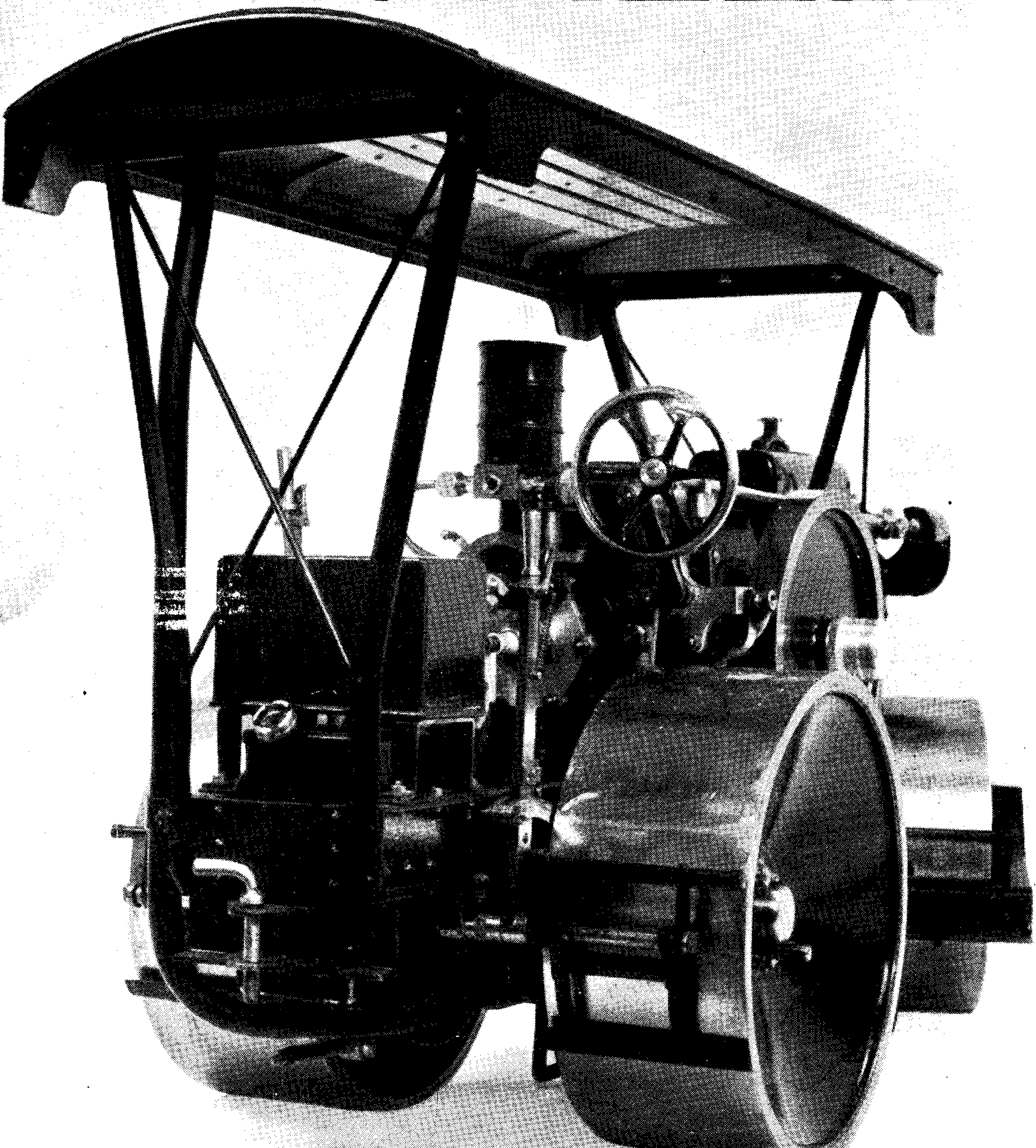
THE MODEL ENGINEER



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The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, GREAT QUEEN ST., LONDON, W.C.2

8TH DECEMBER 1949 VOL. 101 NO. 2533

SMOKE RINGS

Our Cover Picture

● THIS EXAMPLE of the popular "M.E." Aveling-type road roller was constructed by Mr. G. H. Walter, of West Acton, W.3, and exhibited at this year's MODEL ENGINEER Exhibition, where it was awarded a diploma and very highly commended. In a recent letter to us Mr. Walter says: "I first saw two of these rollers side by side in the 1946 Exhibition and was thrilled by the compact and sturdy design, but it was not until February, 1948, that I decided to make one for myself. After studying the drawings, I was even more enthusiastic, as it was apparent that here was a real 'engineering' job, necessitating some nice fits to make a success of it. It has approximately equal amounts of machining, fitting and sheet metal work and is, in fact, an ideal job for the model maker with a 3½-in. lathe. Altogether, I spent over 2,000 hours of very pleasurable work on the model, which television viewers may have seen in Picture Page on Wednesday, August 17th, together with other exhibits.

"I am now engrossed in the delightful occupation of considering what its successor shall be."

Some further photographs of the model have been submitted by Mr. Walter, who has also promised to furnish a description of a boring jig which he devised and used for machining the crankcase and gearbox castings of the model.

Co-operation with Municipal Authorities

● AN INTERESTING example of a model engineering society co-operating with the municipal authorities came to our notice recently. The Cambridge society in its quest for a workshop were invited to use the workshop of one of the schools in the town. The two instructors for the school who, the schoolmaster himself informed us, were most particular about the machines in their charge, have not had a single complaint about misuse of any of the tools, and the relations between the parties concerned have been so harmonious that when the society purchased a new lathe from the proceeds of a previous exhibition it was installed in the school workshop. In addition to its use by the members of the society in the evening, it is also used by the scholars during the daytime as an acknowledgment of the hospitality received. A somewhat similar state of affairs exists at Barrow-in-Furness where, as we have already described, the instructor at one of the woodworking classes gives instruction in model yacht building, a facility which is appreciated by the local model yacht club.

This is the kind of thing we would like to see more of, and when conditions improve, as we sincerely trust they will in the not too distant future, it should make it easier for the authorities to grant facilities for railway tracks and yachting ponds to clubs who are unable to provide them.

Working Model Railway Layouts

● MEMBERS OF the Manchester Model Railway Society are now working at full pressure preparing for the fourth post-war exhibition, determined to maintain the steady increase in the number and quality of the exhibits and the attendances. Last year brought record crowds of over 6,000 in two days: this year the hall has been booked for three days and 10,000 visitors are expected.

As before, the exhibition will be held in the spacious Corn Exchange, Hanging Ditch, Corporation Street, Manchester. It will open on Friday, December 16th, at 11 a.m., and remain open until 9 p.m. on that day. On Saturday, December 17th, the hall will again be open all day from 11 a.m. until 9 p.m. On Sunday, December 18th, the times are from 11 a.m. until 6 p.m.

In addition to a much larger and more representative array of stationary models, there will be no less than six working layouts covering 2½-in. gauge, " O " gauge standard, " O " gauge fine, " EM " gauge fine, " OO " gauge standard and, for the first time in Manchester, " OOO " gauge (2 mm. to 1 ft.).

Neighbouring live steam and model railway clubs have been invited to send exhibits and the Stephenson Locomotive Society and British Railways are both co-operating.

All model engineers and particularly parties from other clubs are assured of a cordial welcome at the Corn Exchange. Exhibition Manager: B. L. Young, 15, Queens Drive, Heaton Moor, Manchester.

Technical Books in Public Libraries

● WE HAVE recently received from the Borough Librarian of Finsbury, London, E.C.1, a printed list of technical books which are available at the Finsbury Public Libraries. We understand that it is intended to be the first of a number of similar lists; but we are interested to note that six of its eight pages contain lists of books which are devoted almost entirely to modelmaking and its allied arts of toymaking, puppets and marionettes. The titles include every one known to us and some that we have not come across previously, and show that the librarian has done his part of the work thoroughly. This is in marked contrast to what we have too frequently experienced in public libraries. Often, when we have made tentative enquiry as to whether any books on modelmaking were available, we have been met with a blank stare which seemed to indicate that the librarian was quite unaware that there could be any books on such a subject. In one case, we found THE MODEL ENGINEER relegated to a none-too-prominent place in the Children's Department!

In other cases, we have found a few technical books, but all quite out-of-date and mostly useless. The Finsbury Public Library, however, seems to be dealing with the matter in a laudable manner, and we are, of course, especially interested and pleased to note that the subject of modelmaking should have been given priority in the technical department. This is an example that might be emulated elsewhere, though we hasten to add that we do not wish to imply that *all* public libraries are necessarily deficient in this respect; in some of the essentially engineering districts in the country, the libraries contain excellent selections of modern technical books. But we do feel that there is a good deal of room for improvement in this matter in many districts in which engineering generally may not be a local industry, though there may be many model engineering enthusiasts living in the area; these people require help and encouragement which, often, is obtainable from books alone, and local libraries should be able to provide, conveniently and quickly, just what is wanted.

A New Model Speed Boat Record

● WE WERE recently informed by Mr. K. Williams, of the Bournville Model Yacht and Power Boat Club, that his boat *Faro* set up yet another new Class " A " record of 56.8 m.p.h. for 500 yds. at Bournville, on November 19th. This record claim has been submitted to the committee of the M.P.B.A. and has been accepted, after due examination as an official record. *Faro* is one of the veterans of the model speed boat world, both the engine and the hull having been built long before the war, and it represents a good object lesson in the possibilities of some of the older boats to hold their own against those of much more modern design and construction. An article on the construction of *Faro* was published in the issues of THE MODEL ENGINEER dated May 12th, 19th and 26th, 1949, in which Mr. Williams refers to the many trials and setbacks which have been encountered in the development of the boat from a comparatively modest speed to record-breaking performance. We commend this record of patience and perseverance to the many beginners who are inclined to get very disappointed if success does not immediately crown their efforts. To the true model engineer, however, difficulties only add zest to the pursuit for high efficiency, and success, when it eventually comes, is all the more satisfying for having been so hardly won.

Enterprising Teamwork

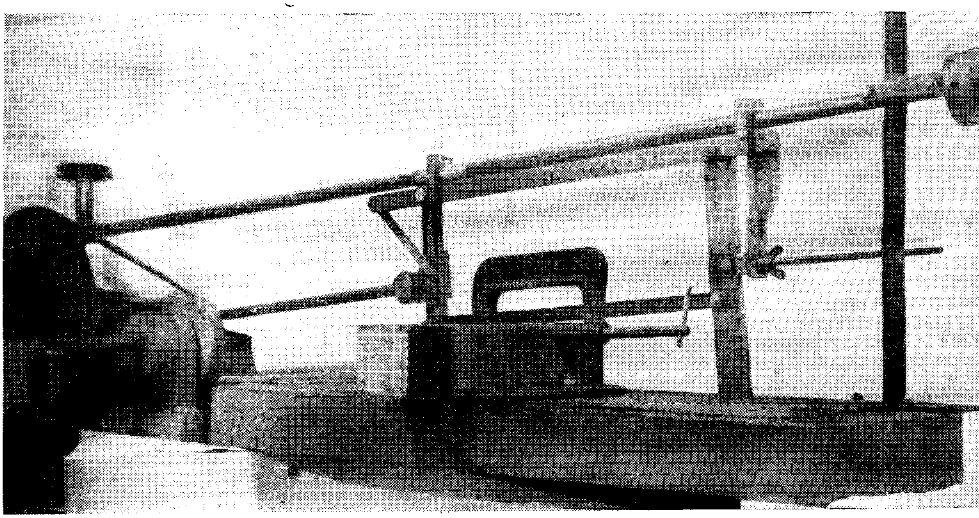
● THE READING Society of Model Engineers, some months ago, undertook to provide a complete model railway which was to serve as a Christmas attraction at McIlroy's stores. Time was somewhat short, but with the aid of admirable organisation, a layout complete with almost every conceivable scenic feature, in 4-mm. scale and occupying a space 36 ft. by 15 ft., was completed and installed in time for its purpose. It was opened by the Earl of Northesk a few weeks ago, and will remain open until January 21st.

The layout is the result of enterprising teamwork on the part of the society, every member of which, be he a railway enthusiast, a ship lover, a petrol engine expert or favouring any other branch of our hobby, has had something to do with the planning and construction of what is surely one of the most complete and attractive model railways ever provided for such a purpose. It is proving a great success, and the society will undoubtedly reap a just reward.

Hacksawing Minus Hard Work

by J. W. Pattison

SINCE I pursue the hobby of model engineering for the pleasure it gives me, it follows that one of the jobs I can enjoy is sawing up small pieces of metal with a hacksaw, but when it becomes necessary to plough through steel bar, maybe some two or three inches thick merely to get a short length cut off, enthusiasm wanes long before the desired result is achieved. Such a state of affairs existed up to some three years ago, when I finally decided to build a machine to do the work. This decision has since left no doubt in my mind that to take all the hard work out of hacksawing, a power-driven machine is really necessary.

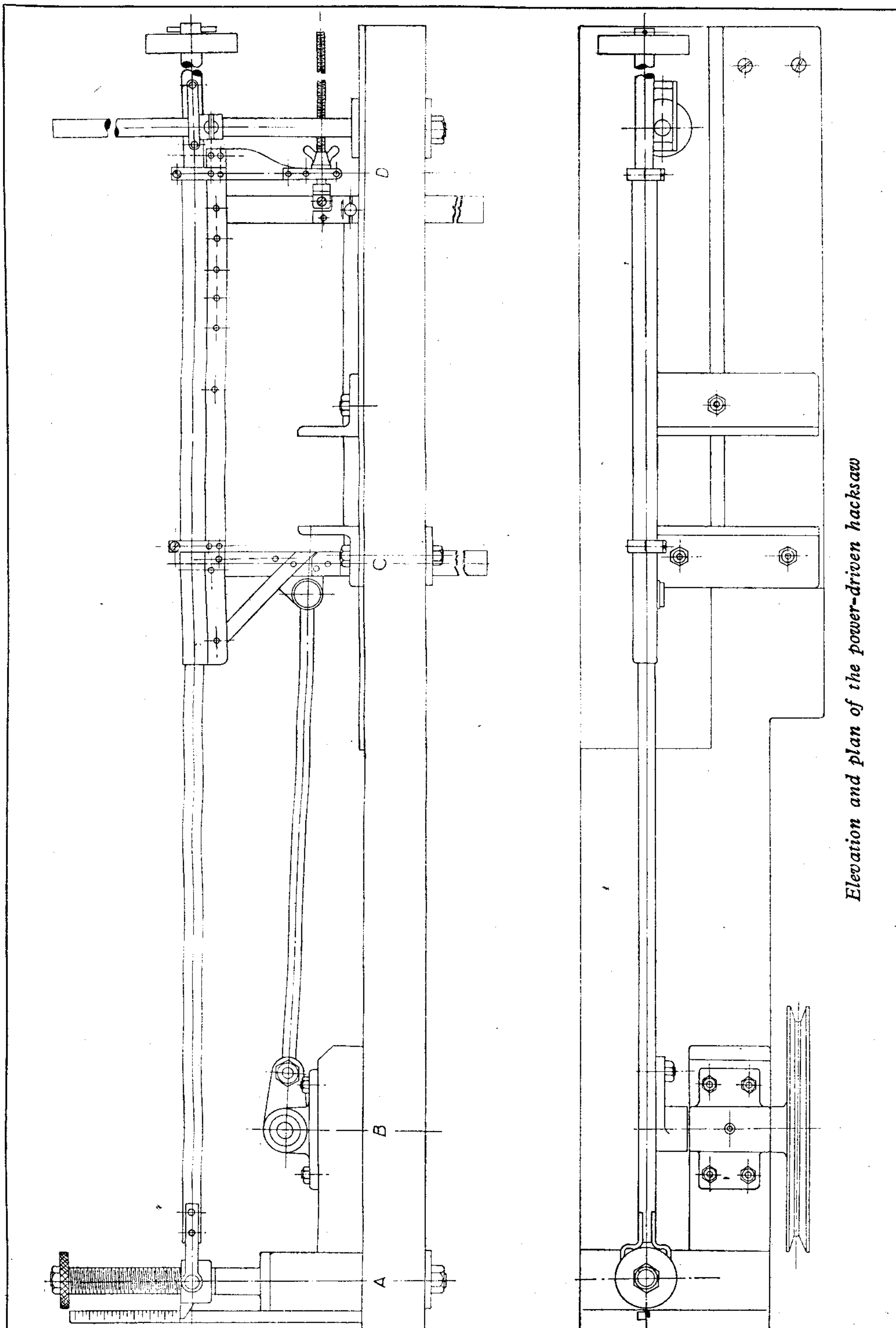


A general view of the hacksawing machine

To trim up small pieces of metal by hand is all very well, but when it comes to sawing through a thick billet of steel, the powered machine scores every time. Added to this, a machine can be made to saw dead straight every time, without any skill on the part of the operator, a point which suits me, though I can at least claim that if I go slowly and take great care I can, nine times out of ten, manage to keep exactly on the scribed line when sawing by hand, and I can still admire the skill of those other fortunate people who can do it every time without apparently taking any of these special precautions.

Having decided to build the machine, some little thought was given to the problem of design, as I wished to use material I had by me at the time. The result has been entirely successful, the machine having since become one of the busiest and also one of the most useful in the workshop. To see it operate while I sit and smoke, has been the envy of several of my friends, and on their recommendations, a similar one is to be constructed as a club effort to be used in the society's workshop, moreover many members intend to build one up for their own use. This being so, I thought it might be of more than passing interest to other readers of THE MODEL ENGINEER.

A commercial machine owes its rigidity usually to the heavy casting which guides the saw frame, and it makes use of a special blade which is much broader than one of the hand frame type, thus, by comparison with the latter, more pressure can be applied, and consequently heavier cuts taken. The machine to be described, however, is not intended to be classed with its commercial counterpart, even though rigidity is achieved by virtue of the saw frame being guided at both top and bottom ; it is intended that only the lighter type of blade be used which, by the way, is always available in any amateur's workshop. No special claims are made for its cutting speed although this is much faster than by hand, the limit being reached when the pressure applied causes the light saw to buckle. The only remedy, if faster cutting is required, is to make use of the heavier type of blade on which more pressure can be applied. Used within its limits, however, the machine will be found to give every satisfaction and if allowed to run lightly, that is without excessive weight being applied to the end of the guide-rod, the resultant cut surfaces will have a smooth matt finish without sh[illegible] the slightest sign of saw marks ; in fact, [illegible]

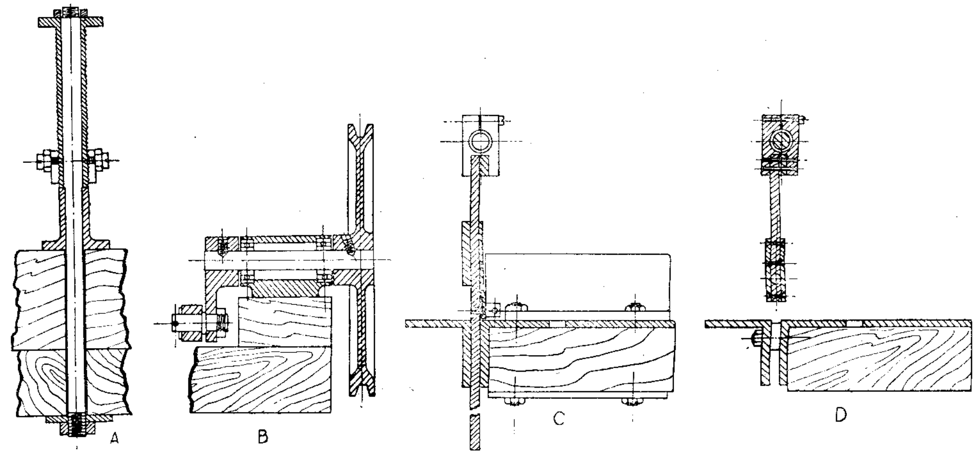


Elevation and plan of the power-driven hacksaw

better surface than can be produced with a dead smooth file.

The machine has two special features, neither of which I have seen described before. First the method of guiding the saw frame at both top and bottom as already mentioned, and secondly the arrangements made for the saw to finish level in the cut at any predetermined depth. This latter feature is very valuable when making up say, for example, a tool post with holding-down feet or maybe a plummer block of incorporating in the design, and, of course, the blade couldn't then be reversed. Incidentally, I have yet to experience a saw breakage. An adjustable stop is provided for use when cutting to a fixed depth, and the guide-rod pivot may also be raised or lowered should it be desired to finish the cut level. For all ordinary cutting off, this pivot is set to its lowest point, when the saw will finish parallel with and just touching the table.

It will be noticed from the drawings that the



Sections on A.B.C.D. of the elevation drawing

cut from the solid. With such a job as this the saw can be started and taken down to a definite depth finishing level, the job being then set up at right-angles and the saw again run down until it meets the previous cut, when the waste-piece will fall out leaving a perfectly finished corner without any undercutting.

I have undertaken several jobs of this nature with every satisfaction, even though I have a horizontal miller in the workshop. Oddly enough the hacksaw is driven off the miller's gearbox! For cutting off flat bar the machine is ideal; indeed, I cannot think of a better method of doing such a job. If a piece of flat bar of, say, 3 in. × ½ in. section is laid flat in the vice and the saw allowed to traverse the broad face, the resultant finish and squareness of cut is a joy to behold, and as for general sawing up of stock material, all that need be said is that the machine saves one all the hard work.

A feature of less importance is that any size blade may be used from 6 in. to 1 ft. in length. The 6 in. size may sound superfluous, although I have, on occasion, used a junior hacksaw blade by knocking out the pins and enlarging the holes. As to economy, the machine appears to work equally well with the saw teeth pointing in either direction, allowing the blade to be reversed before being finally discarded. I might add that I am quite aware that this is not strictly getting something for nothing, as the machine could have been made to ease the pressure on the return stroke, but in a machine of this type, such a refinement would hardly be worth the trouble vice, which is made from angle iron, appears to lack a pressure screw, but this is because I personally find it much quicker and easier to just span the fixed and movable jaws with a "c" cramp. A regular pressure screw could, of course, be added if desired, although I can recommend a cramp if a suitable one is available. Occasionally I have used the machine with two or more blades in the frame at once, thus making it useful for say, cutting a keyway in a pulley, a job which it performs with every satisfaction. For all normal sawing the best speed appears to be about 90 strokes per minute.

Construction

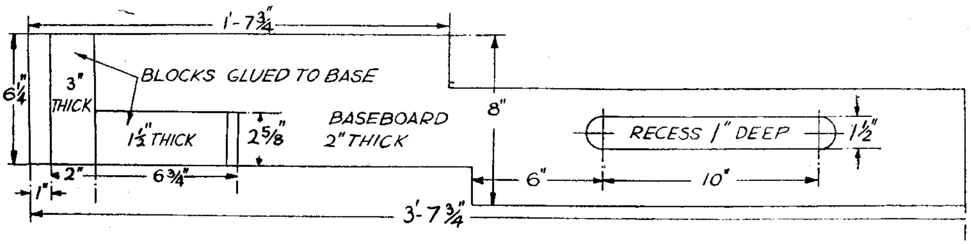
Obviously, certain liberties can be taken in both the design and construction of a machine of this type without materially affecting its efficiency, though my advice is to follow the drawings as closely as possible, particularly in the length of the connecting-rod, which greatly reduces the angular thrust; and makes for smoother running. Having come to definite conclusions, start by making the lower saw guides and fitting them to the baseboard. These are of 2 in. angle roughly about $\frac{3}{16}$ in. thick. Cut off a couple of lengths to the dimensions shown and clean up any roughness. A spacer ¾ in. × 2 in. and another 2 in. × 2 in. and slightly over ¼ in. in thickness is riveted one at each end and finally drilled as shown for holding the assembly to the baseboard, either by woodscrews or ¼-in. bolts. Woodscrews will be quite satisfactory, as rigidity is secured by the vice holding-down

bolt and the vertical pillar. It is unlikely that spacers of the right thickness will be at hand, so use $\frac{1}{4}$-in. plate plus a shim of tinplate to bring it up to the required thickness. The distance apart will depend upon whether or not bright drawn angle is used, but the essential thing is that the long legs of the saw frame must slide freely and without undue shake between the guides. Next, we require a baseboard and this may be got out of any suitable wood approximately 2 in. in thickness. Cut out the section at the rear side to accommodate the guides, removing sufficient wood to allow the guides to take up a position continuous with the rear edge of the baseboard. Before securing, cut the slot on top of the baseboard to accommodate the bolt head of the movable vice jaw. The neck of this bolt travels in a slot formed by the near edge of the guide assembly, and a piece of plate of similar thickness spaced $\frac{7}{16}$ in. from it. The size of this plate is 1 ft. $6\frac{3}{4}$ in. $\times$ $3\frac{1}{4}$ in. and when bolted down on the baseboard should form a level table with the rest of the guide. The bolt which locates the movable jaw of the vice is the next job, together with two lengths of heavy angle to form the vice jaws. The vertical column, which locates the movable or free end of the horizontal guide-rod, can now be machined to dimensions, screwed at its lower end, and a collar fitted against the shoulder. If preferred, the collar could be brazed to the bar or even held against a shoulder formed by a $\frac{3}{16}$-in. pin driven in crosswise without setting the bar up in the lathe. Personally, I prefer the machining method, as it ensures the column standing vertical, which is essential. Having got this done, the guides can be fitted in place on the baseboard by woodscrews through the spacer holes and the top drilled to take the vice and column. The whole lot can be bolted together, not forgetting to put the loose vice bolt in its slot before finally tightening up.

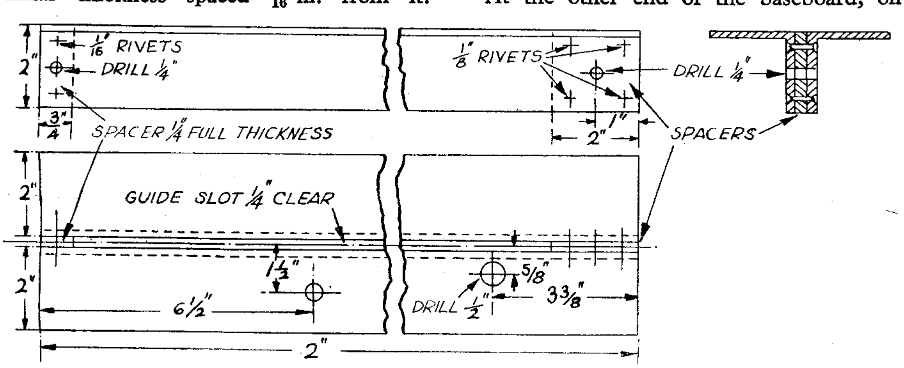
Assuming the baseboard was nicely planed up in the first instance, we should now have a nice metal table top on which the vice can work and with the saw guides and column standing vertical and exactly at right-angles to its surface. If anything is found to be out of plumb, now is the time to put it right before proceeding further. Put a length of flat bar in between the guides, and together with the vertical column, test with a square. Failure to stand vertical will throw the whole machine out of line and the saw will not cut true.

At the other end of the baseboard, on the nearside, another section of wood is removed to accommodate the driving wheel, and in my case a small reduction pulley, the shaft of which is an extension of the gearbox on the milling machine. If other arrangements are made for driving, only sufficient wood need be removed to allow the driving wheel to operate. To complete the woodwork, plane up nice and true a couple of blocks of wood and glue them at right-angles to each other on the baseboard in the positions shown in the drawing. One is to provide a substantial anchorage for the pivot bearing of the upper guide-rod, and the other to support the crankshaft bearing.

(To be continued)



The baseboard



Details of the saw frame guide

PETROL ENGINE TOPICS

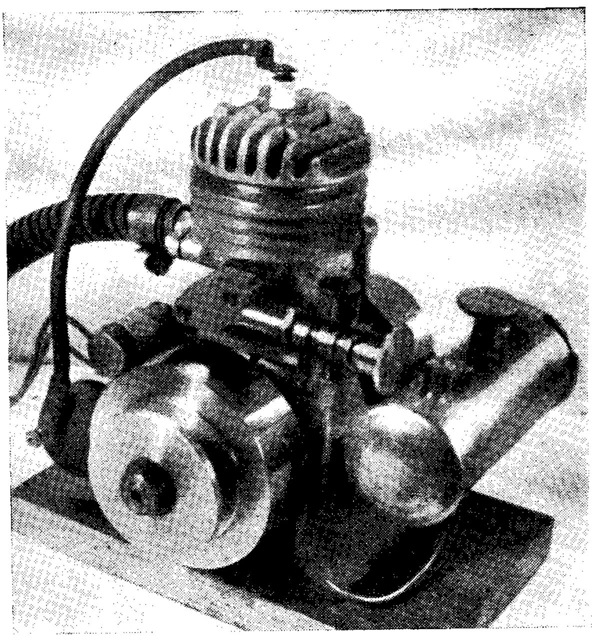
*A General-Purpose 15-c.c. Two-Stroke

An Elementary Exercise in Model Petrol Engine Construction

by Edgar T. Westbury

AFTER completing the main machining operations on the cylinder barrel casting, it may be set aside for the time being, leaving the drilling of the various tapping and clearance holes until a later stage in the construction. The cylinder head casting may be taken in hand, and for machining this in a small lathe it may be found necessary to deviate from orthodox methods. It would obviously be desirable to hold this in the chuck with the joint face outwards, to face this surface and machine the inside of the combustion chamber, and drill and tap the sparking-plug hole, all at one setting; then reverse the casting, bedding the joint face firmly against the chuck jaws or body, to face the top surface of the plug hole.

Owing to the depth of the finning, and the relatively short reach of the chuck jaws on a small lathe, however, it will probably be found impossible to carry out the operation in this way, and the alternative, less efficient, but inevitable, will be to hold the casting in the reversed position, and face and drill the sparking-plug boss first. The majority of constructors will probably adopt the 3/8 in. × 24 t.p.i. plug, as this size is readily obtainable, and has been found quite satisfactory in an engine of this type; but as an alternative, either a 10-mm. or 12-mm. plug may be used, and as such plugs are designed for use in full-size engines, it is possible that they are more robust in construction and better suited to continuous running than the smaller size.



The first experimental engine of this type, which was destroyed in a fire (see page 668, November 24th issue)

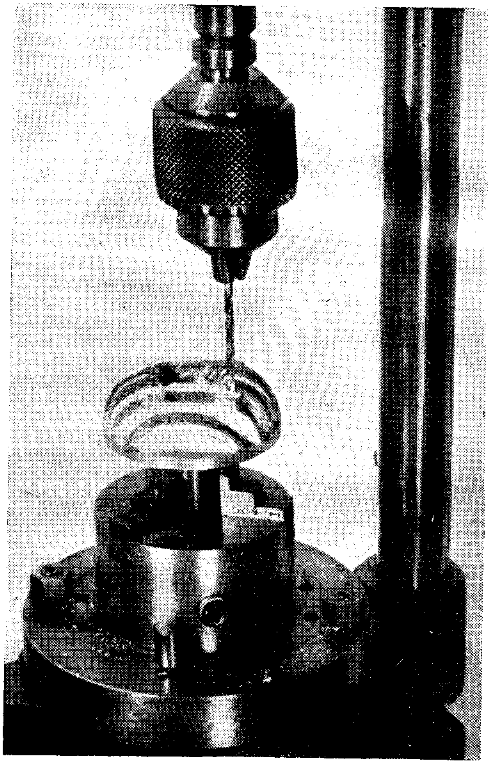
When tapping the sparking-plug hole (taps to suit the 3/8-in. plug are available from tool dealers advertising in the "M.E.") care should be taken to produce a clean thread, exactly concentric and true with the lathe axis, and to face the outside of the boss equally truly to provide a good seating for the shoulder of the plug. The mouth of the thread should be bored out to clearance size for the depth of about one thread, to ensure that the plug will screw fully home against the shoulder, even when the joint washer is not fitted; this also facilitates entry of the plug and reduces the risk of cross-threading, but should not be overdone so as to skimp the effective length of thread left in the hole.

A stub mandrel should now be made to hold in the lathe chuck, the end being turned down and threaded to sparking-plug size. Some constructors may be tempted to use an old plug body for this purpose, but it is not a good policy, as the length of the body is not sufficient to enable a really firm grip to be obtained, and it may also be found difficult to get the screwed end to run sufficiently truly. The screwed stub mandrel, having sufficient length and large enough diameter to ensure rigidity when chucked, is much better, and it is sure to be found useful on many subsequent occasions.

The casting is now screwed on to the mandrel, joint face outwards, and the rest of the machining carried out at this setting. It will not be quite so rigid as if held directly in the chuck, but by using keen and not too broad tools, and moderate feed, no difficulty will be experienced. The inside of the combustion chamber should be finished

**Continued from page 671, "M.E.," November 24, 1949.*

as highly as possible, and the use of a hand tool is recommended for finishing the internal radius. It should not fit the radius, or it will be liable to cause chatter; use a much smaller radius on the tool, so that only a comparatively narrow edge is in use, and keep it on the move to produce a regular sweeping curve. A tool shank held crosswise in the tool-post will serve as a hand rest. These details are mentioned because many readers seem reluctant to use hand tools for some reason or other, but I find them almost indispensable for many operations, and they are very easily made from small files which have outworn their original function.



Drilling the holes for holding-down studs in cylinder-head

When drilling the holes to take the holding-down studs, it is advisable to mark out their positions on the bosses of the casting so that they are all exactly on the same pitch circle and spaced 90 deg. apart. Some constructors may consider it sufficient to drill the holes in the centre of the bosses, and spot the tapping holes in the cylinder casting from them, which is quite satisfactory from the purely functional aspect, so long as the head is always fitted in one position. But there may be occasions when it is desirable to be able to change the position—such as, for instance, if the engine is for any reason located with its shaft at right angles to the motion of the cooling air—and in any case geometrical accuracy is always desirable from the aspect of good craftsmanship.

In most of the operations of this nature which I have carried out, I use a drilling spindle in the lathe, in conjunction with indexing gear on the mandrel, and this method is the best I know for ensuring accuracy. But when building the engine illustrated, Mr. Message did not have access to these facilities, and it was necessary to mark out the holes in the more orthodox manner, and drill them in the drilling machine. There was, however, a simple form of 12-station dividing head available with a chuck mounted on it, and this was clamped to the table of the drilling machine, having first been set to correct radius relative to the drill spindle centre. The head was held on its stub mandrel (as no inside-stepped chuck jaws were available) and adjusted for angular position of the bosses. A small centre-drill was used to start the holes, entering it as deeply as possible to ensure sufficient guide for the following drill to avoid the risk of it running off centre. After drilling, the bosses were spot faced with a home-made facing cutter.

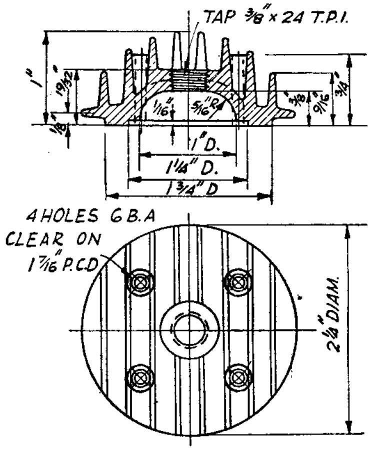
Cylinder Liner

In full-size practice, it is common to machine cast-iron liners from a cored "quill," having a large diameter flange at one end, which, after dressing roughly on the back face, so as to bed fairly to the surface of the faceplate, is clamped thereto and set up so that the main cylindrical portion runs truly; all external and internal machining is then done at one setting, and the liner finally parted off. Although this entails a good deal of waste material, since the flange is usually scrapped, it has the advantage that the liner is free of all clamping stresses such as would be caused by holding it in a chuck. It is really surprising how much distortion can be, and often is, caused in this way, in parts which are believed to be quite accurately machined.

If a special casting is made for the liner, it may well be provided with a flange and dealt with in this way, especially as the moulder, if he understands the requirements and is willing to co-operate, can arrange the casting in such a way that any slag, or lack of homogeneity, is concentrated in the flange rather than the liner. Alternatively, the end of the casting, which should always be long enough to allow for chucking, may be left solid so that it will withstand the pressure of the chuck jaws to best advantage. If chill cast or centrifugal iron is used, I have found solid material preferable to cored, as the initial internal cuts on cored cast-iron are often a sore trial on tools and temper, and often take longer than drilling and boring from solid.

In any case, the work should be held as firmly as possible in the four-jaw chuck, and slow speed is essential, except perhaps for centring and drilling a pilot hole with a drill not larger than ¼ in. If the outside is rough-cast, the back centre can be used to support the end while taking an external roughing cut, deep enough to get well under the skin; the lathe should be run at the slowest back gear speed for the first cut. The machined surface will serve as a "witness" in case the work should tend to go out of truth

in subsequent machining. Take the outside down to within $\frac{1}{16}$ of finished size, and then if suitable drills are available, open up the bore by easy stages—not more than $\frac{1}{4}$ in. at a time—to within the same limit, still keeping the speed the same. For boring to final size, a slightly higher speed may be used, providing that it does not produce a tendency to chattering. Use a boring tool, or a bar with an inserted cutter, of the largest possible diameter, to promote rigidity. If time allows, it is a good idea to leave the



Details of cylinder-head

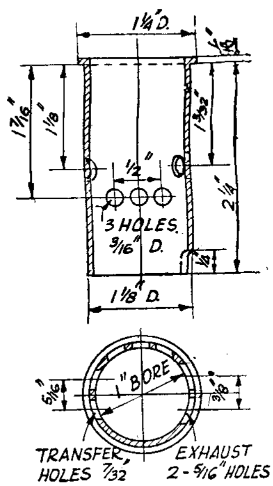
casting to " season " for a few weeks after rough machining, in order to release internal stresses before final machining ; I have encountered many cases where serious distortion has occurred after every care has been taken in initial machining, and this can only be accounted for by the presence of stresses in the casting.

Incidentally, some constructors are often tempted to side-track the difficulties of machining cast-iron by using drawn steel tube for cylinder liners. The ordinary grades of tubing, however, are entirely unsuited to take heavy sliding wear, and though special tubing having a higher carbon content is made, and will give much better results, it is still inferior to cast-iron, according to evidence obtained by careful running tests. It is only when extra mechanical strength is essential that the use of steel cylinders is really justified ; and as I have pointed out in previous articles, the case-hardening of liners, apart from risk of distortion, is a dubious advantage, because the liners often reach a high enough temperature to soften the steel, at least locally, which is worse than equal softening all over. I make no apology for reiterating what I have said so often before—there is no " ordinary " material to equal cast-iron for taking sliding wear.

Lapping the Liner

The liner may be machined to within about 0.002 in. of finished size, internally and externally, before parting off. Every care should be taken to produce as parallel a bore as possible, and by using a keen, properly set tool, to obtain a high tool finish, free of scores or chatter-marks. Remember that the higher the accuracy at this stage, the shorter will be the lapping operation. Finish of the outside surface is not quite so important, and it is permissible to use a superfine file for final fitting to the bore of the cylinder barrel, but only a very small amount of metal should be left for removal in this way.

Lapping of cylinder bores has been described several times in the " M.E.," both by myself and other contributors, but readers seeking further guidance in this matter may find it in the " M.E." handbook, *Grinding, Lapping, and Honing*. Almost any abrasive is suitable in some degree for lapping, the harder and sharper abrasives such as carborundum being obviously best suited for coarse lapping, involving the removal of tool marks and local inaccuracies ; their use should be continued until one is satisfied of the general truth of the bore. Finer and softer abrasives are used for finishing, in successively finer grades, according to the degree of polish required ; but the initial lapping is the most important from the aspect of accuracy. High polish of an initially accurate surface will, however, reduce destructive wear and enable accuracy to be maintained longer than if the texture of the surface is coarse. Expanding laps are, in my opinion, essential, and I favour also short laps as they enable the action of the lap to be localised, and taper or other local inaccuracies detected by feel. The main lapping operations should be carried out before drilling the ports in the liner, but final lapping afterwards is necessary to remove burrs and other slight inaccuracies caused in drilling.

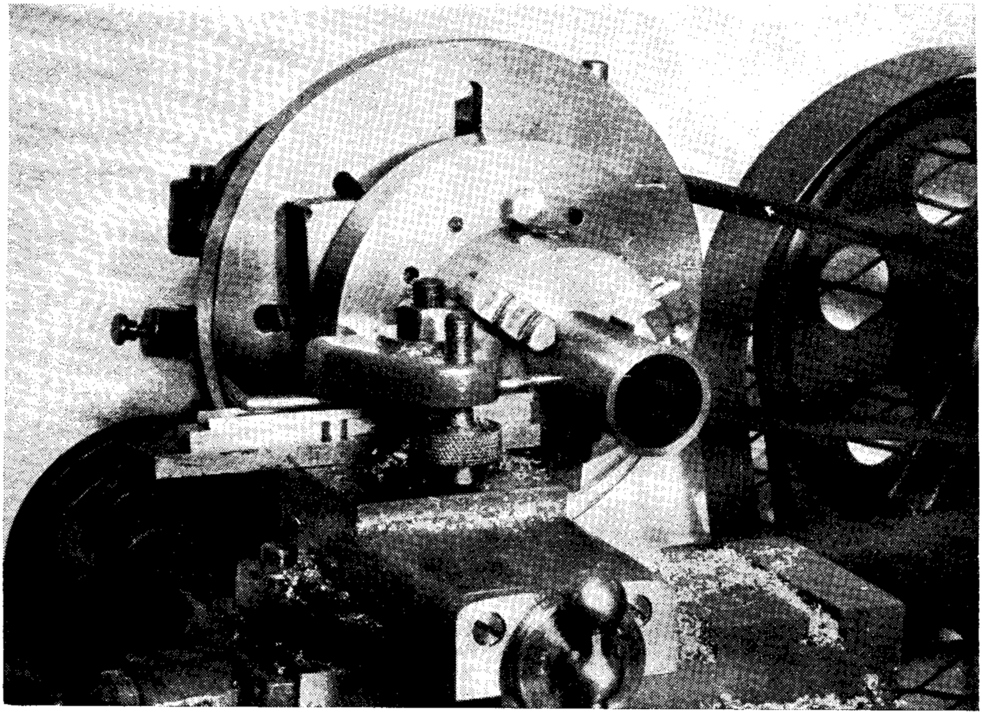


Cylinder liner

Marking-out Ports

To locate the ports correctly, it is advisable to hold the liner in the lathe, either on a mandrel or in the chuck, and use a scriber held in the tool-post. Concentric lines should be marked at carefully measured distances from the lip of the liner, and cross lines scribed to intersect

them, the use of some form of indexing device being desirable to ensure accuracy. In the case shown, the indexing head which has already been mentioned was set up on the faceplate and used for this purpose. If a sharp scriber is used in this way, it will be possible to locate the centres of the holes very clearly and accurately, which is a prevalent cause of distortion in small engines. The barrel may have a very slight taper, up to about 0.001 in. in the length, and should be an easy push fit for about half-way, with the barrel cold; warming the latter to about the boiling point of water should enable the liner to be pushed right into the shoulder.



Marking off the port centres in cylinder liner with a scriber held in the lathe tool post

after which they are marked with a fine centre-punch and pilot holes drilled, prior to opening out to finished size of the ports, which differs in all three sets.

Round holes have been specified for the ports in this engine, because I find that many beginners are very dubious of their ability to file out ports of the correct shape and location, but are much more confident about the location of drilled holes. Such ports have proved quite satisfactory in several of my engines, including the "Kestrel" and "Atom Minor," in spite of the fact that they do not provide quite as large a port area as rectangular ports; they are, however, generally kinder to piston rings in cases where the latter are not pegged. Constructors may, however, file out the ports square if they wish, taking care not to make individual ports too wide, to avoid trapping the rings, and also preserving the specified depth and location, with adequate bars between ports to support the wall of the liner at these points.

In fitting the liner to the barrel, great care should be taken to avoid excessive tightness, If the barrel has been machined as described, with reference to the location of the cored ports, they should line up with those in the liner; but in the event of error, the latter can quite easily be removed to allow of correcting matters.

It may be remarked that in my earlier engines which were fitted with inserted cylinder liners, I went to great pains to fit the liner very tightly by making it at least 0.0002 in. oversize and heating the outer shell to a high temperature for shrinking in. The idea was to ensure good metallic contact and heat conductivity despite differential expansion of the two metals. After many years' experience, however, I have found this quite unnecessary and indeed detrimental, as the parts are always in a state of stress and, therefore, liable to distortion. Easy fitting of the liner ensures that it is free of centripetal stresses, and this not only avoids distortion, but also appears to give quite good heat conductivity, as the liner is always hotter than the shell, and very little difference in expansion appears to take place.

(*To be continued*)

*A Domestic Refrigerator

by L. C. Sherrell

DETAILS of the seal housing are given in Fig. 2, this has nothing to do with the aquarium as might be supposed, but is the part that holds the ball-race (Hoffman L.S.7, size $1\frac{9}{16}$ in. o.d. × $\frac{5}{8}$-in. bore × $\frac{7}{16}$ in. thick), and the seal (Fig. 4), which is used to prevent the gas escaping from the compressor around the crankshaft. I will just describe this seal whilst on the subject; it consists of a bronze ring soldered to a copper bellows, which is in turn soldered to a brass seal flange. A stiff steel spring surrounds the bellows, with one end bearing against the brass flange and the other against the bronze ring. The face of this bronze ring is lapped dead flat and smooth, and great care should be taken when fitting, as should it get scratched or marked, to put it bluntly: you've had it. In operation, the rubber ring called a "Duprene" ring, the distance-piece, and the hardened cup-ring revolve with the crankshaft. On finally assembling, the distance-piece must be machined to such a length to leave a gap of $\frac{3}{16}$ in. between the brass flange and the face of the housing; this will give the correct amount of tension between the rubbing faces and make a gas-tight joint. These seals complete with Duprene ring, etc., are obtainable from any refrigerator maintenance engineer. It won't be necessary to give machining details of this housing, it is quite straightforward, the drawing being self-explanatory. The ball-race wants to be a nice tap in fit, it is to be hoped some of the advertisers will be able to produce castings for these various parts, as it requires a lot of work and patience to plough this particular part out of solid mild-steel even if it were possible to obtain a piece $4\frac{1}{4}$ in. diameter.

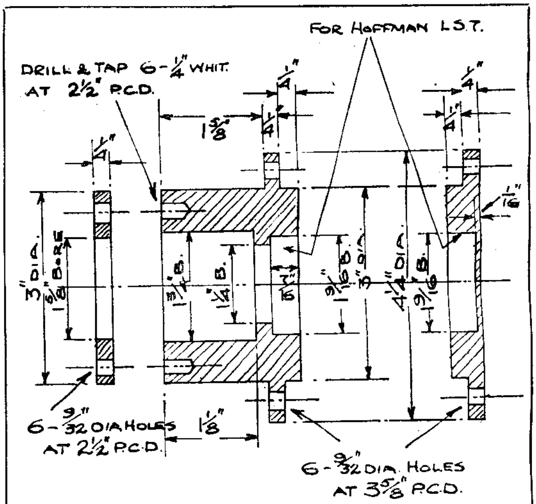


Fig. 2. Compressor details—seal housing and plate, and end cover

Mark the holes out to the given centres and drill 13/64 in., press into left-hand side of crankcase, that is with the suction flange farthest away from you, and run the same drill through the side plate; if you've made it the right fit, there will be no need to clamp. Tap out $\frac{1}{4}$-in. Whit. Open out holes in housing to 9/32 in.

The end cover-plate which will go in the other side is treated in the same manner.

The Cylinder. Fig. 3

The cylinder, which is $1\frac{1}{2}$-in. bore, is of close-grained cast-iron, and should be treated with the same respect as if it were for one of Mr. Westbury's engines. I don't think it is necessary to explain machining operations for this, as he has done this quite often and far more expertly than I could hope to do.

Before the lapping operations are commenced, however, the cylinder must be tested to a pressure of not less than 150 lb. This can easily be done, with a $\frac{1}{4}$-in. plate each end pulled up tight on a rubber washer with a $\frac{3}{8}$-in. bolt through the bore. Adapt a Schrader valve by turning the outlet end down to 7/32 in. diameter, and sweat it into any suitable taper plug that can be screwed into one of the $\frac{1}{4}$-in. plates. Now get a foot-pump to work, a pressure gauge won't be necessary, as with the average foot-pump this pressure is about the maximum. Test in a bucket of water; if there's the slightest bubble it won't do. You've one chance, however, drive a wooden plug in each end of the bore and make the acquaintance of the local chromium-plating expert who, for a few pence, will be pleased to nickel same for you. Run your odd ends of solder down in a tin that the cylinder will just fit and with a good coating of Baker's fluid treat it to a hot dip. This will fill up any porosity. Remove and shake off surplus solder and stand aside to cool. Test as before, if O.K. proceed with the lapping. The four holes for bolting to the crankcase can be drilled; use the cylinder-head as a jig for the others.

The Cylinder-head. Fig. 3.

This is made from a piece of $2\frac{3}{4}$-in. round mild-

*Continued from page 687, "M.E.," December 1, 1949.

steel machined up to finish $\frac{7}{8}$ in. long. Bore out to $1\frac{7}{8}$ in. diameter for $\frac{5}{8}$ in. of its length, and run $\frac{3}{8}$-in. drill through the centre, bolt the delivery flanged-piece on and weld, watching points to see that it looks the same as the drawing, mark out and drill the six 9/32-in. holes.

The Motor Pulley and Fan. Fig. 3.

This is quite straightforward. Four slots can

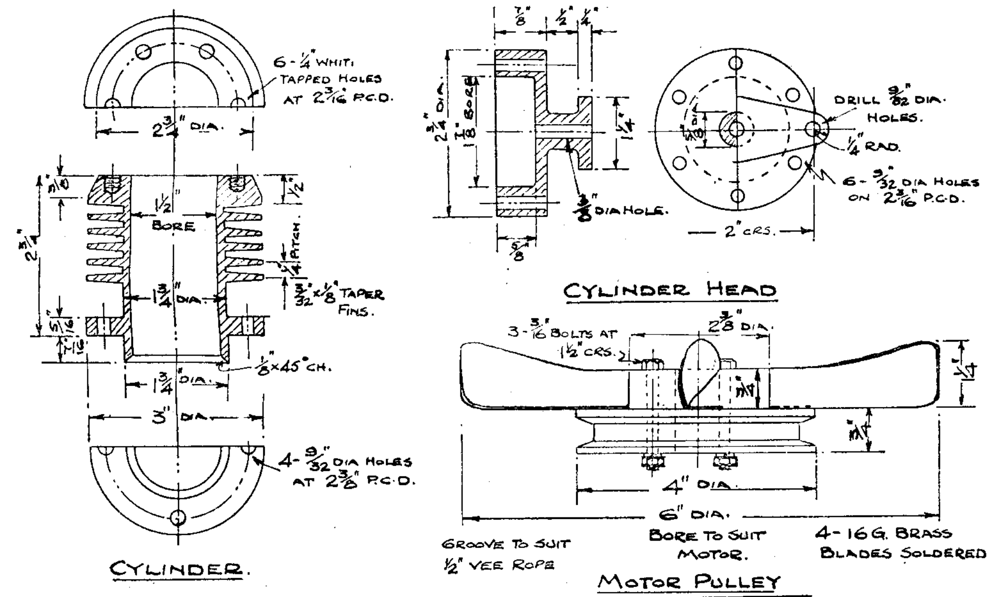


Fig. 3. Compressor details

be sawn across the $2\frac{3}{8}$-in. diameter boss at 45 deg. and the blades sweated in. A $\frac{3}{8}$-in. grub-screw in between two of the blades will hold it on the motor spindle.

The Delivery- or Discharge-valve. Fig. 4.

I found this little joker a bit of a teaser, as it must hold and maintain a 20 in. vacuum for at least a 10-minute period.

The best results were obtained with a $\frac{3}{8}$ in. thick cast-iron plate $2\frac{3}{4}$ in. diameter. Face one side, turn it round and face the other, getting the best finish possible, centre and drill right through with a $\frac{1}{4}$-in. drill ; now, with a sharp-nosed tool and leaving only a $\frac{1}{16}$ in. seating area all around the hole, feed the tool in about 0.003 in. and come out until a diameter of $1\frac{3}{4}$ in. is reached, remove any sharp edges around the seat. It can now be clamped to cylinder-head by a $\frac{1}{4}$-in. bolt through the centre and drilled. Strike a line through centre of valve plate and at $1\frac{1}{4}$ in. centres drill and tap for 2-B.A. screws, taking care not to let the drill break through, there is the possibility the gas will get by if you do.

The valve seat may now be lapped dead smooth on a piece of plate glass, using a medium compound. It is advisable to watch progress made with a magnifying glass. Finish off with metal polish and then a smear of oil only on the lapping block. Make two screws and springs (Fig. 1A) not forgetting the $\frac{1}{16}$ in. hole in the screw head. This is to wire them firmly together, we don't want them working loose. Before fitting the polished spring steel reed, wash the valve plate in petrol (red or white). The reed cover-plate is bent up from a $\frac{1}{2}$-in. × $\frac{1}{16}$-in. steel strip.

It can be assembled and tested by bolting to cylinder-head, tip a teaspoonful of petrol through the flanged-piece, rig up the Schrader valve, pump up to about 60 lb. pressure. If no bubbles get by the reed it will be O.K.

The Connecting-rod. Fig. 4.

This is made from a piece of $\frac{5}{8}$-in. square mild-steel, 2 in. long. Face and centre each end. The safest way to ensure the hole being concentric is to set it up in the four-jaw chuck and bore out to $\frac{3}{8}$ in. diameter, face $\frac{1}{8}$ in. off to top of hexagon, turn up a short stub and machine the other side likewise. The thread is screwed between centres. Make a bush from phosphor-bronze, drive in and drill 3/32-in. oil hole.

The Piston and Valve. Fig. 5.

If no castings are available the piston can easily be made as per the drawing, the body should be of cast-iron having a coefficient of expansion equal to that of the cylinder. If, as is most likely, the piston rings are obtained ready-made, the width of grooves on the drawing will not apply. They are for my own rings, made as described by Mr. Ian Bradley in THE MODEL ENGINEER a few years ago and up to the time of writing have proved quite satisfactory.

The small-end can be made of mild-steel sawn or milled out to size and the seat lapped, in the same manner as the discharge-valve. The small-

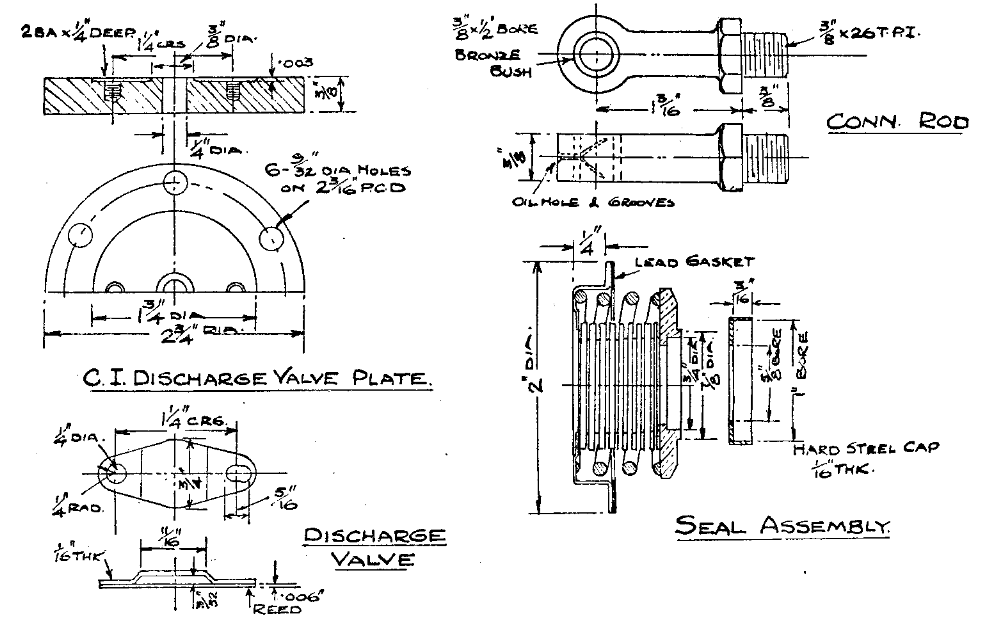


Fig. 4. Compressor details

end pin, which is finally case-hardened, is a tight fit in the holes, any slack at this joint and you'll know all about it at the top and bottom of every stroke when the compressor is under load.

The piston-head is also mild-steel. The two $\frac{5}{16}$-in. gas ports are filed in after screwing and parting-off, don't make the recess any deeper than 1/32 in. This is quite enough lift, given any more will make a clatter. The threads should be well fitting, and when finally fitted, complete

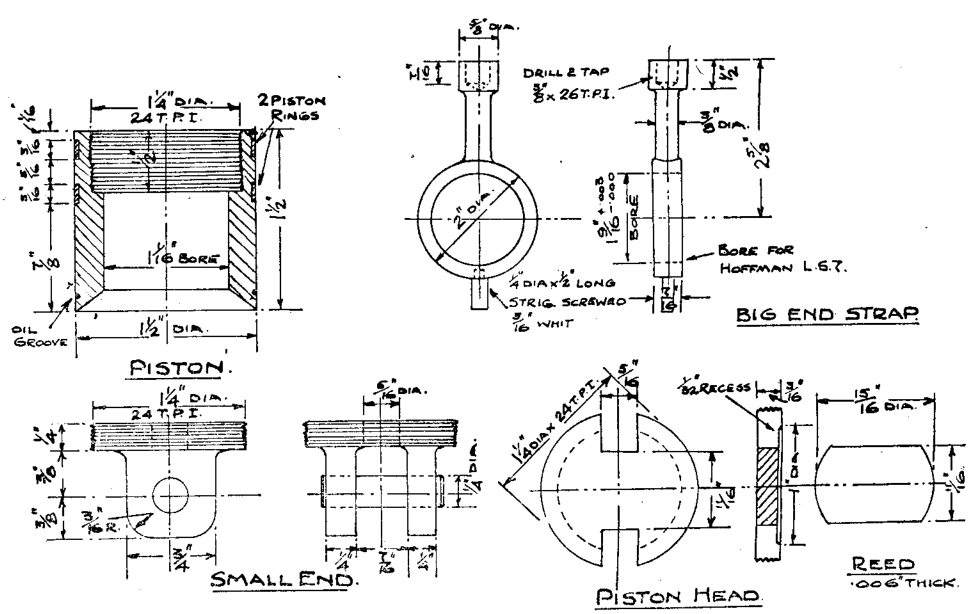


Fig. 5. Compressor details

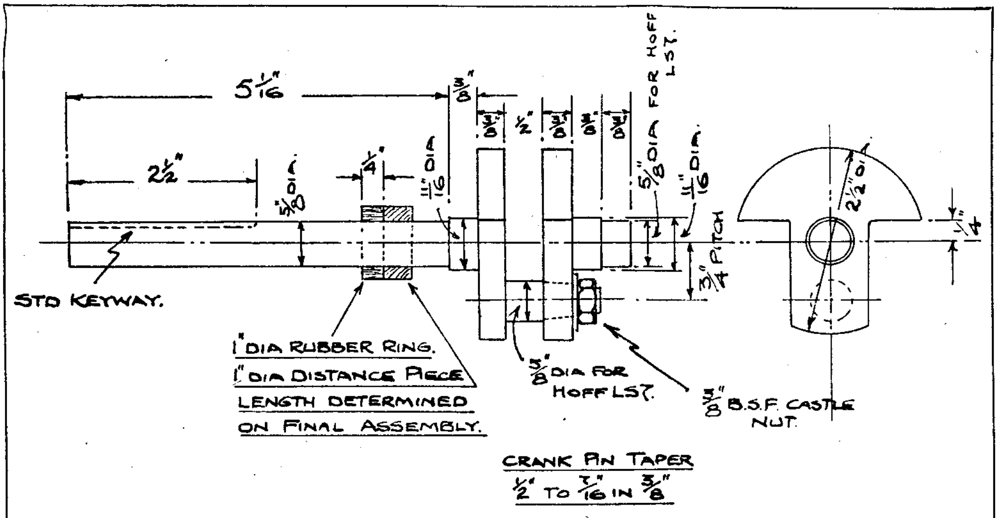


Fig. 6. Compressor crankshaft

with connecting-rod, the piston-head is locked down tight on to the lapped face of the small-end, taking care that the spring reed remains free.

The Big-end Strap. Fig. 5.

This is sawn, filed and machined from a piece of 2-in. × $\frac{5}{8}$-in. × $3\frac{1}{4}$-in. long mild-steel in the same way as described for the connecting-rod, and the ball-race pressed in. For the benefit of the novices I must stress the importance of machining these parts accurately, or they will never get them to line up when they start to assemble.

The oil-splashing strig is not screwed in until the crankshaft is installed in the crankcase.

for the lubrication of this type of bearing. As I have mentioned, this is beyond the average model engineer whose equipment is limited to a small lathe, drilling machine, and possibly a few minutes with somebody's welder. However, we shall only require one off and if it should take a month to make, what matters: provided it will last for years, giving smooth and silent service—let's get down to it.

Two pieces of $2\frac{1}{2}$-in. round mild-steel are required $7\frac{1}{8}$ in. and $1\frac{3}{16}$ in. long respectively. The longer piece is faced and centred and turned down to $\frac{11}{16}$ in. diameter for $5\frac{7}{16}$ in. of its length. The short piece is faced both sides, centre one and turn down to $\frac{11}{16}$ in. diameter for a length of $\frac{3}{4}$ in.

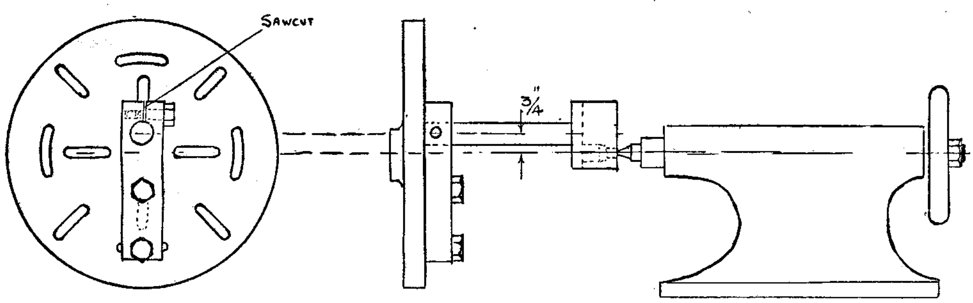


Fig. 6a. Jig for machining crankshaft

The Crankshaft. Fig. 6.

This, I'm afraid, is the most tedious part of it all, it is turned from $2\frac{1}{2}$-in. round mild-steel. I would not advise welding or brazing, as it has a big job of work to do, and should it break, a lot of damage can be done. The majority of commercial compressors have eccentrics and sleeve bearings of very generous proportions, with hardened and ground crankshaft, and a very large crankcase to accommodate the oil necessary

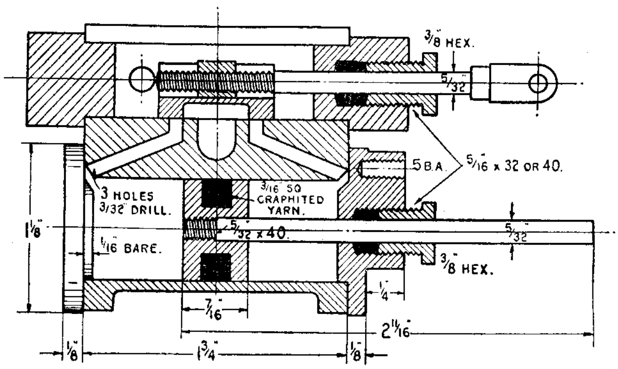
To machine the throw, a jig, similar to the one shown, can be made and bolted to the faceplate. Machine the long half first making the journal diameter exactly 0.625 in., which will allow the race to tap on quite comfortably. Without moving the jig, mount the short end in it and bore out to the same taper as the male, allowing a $\frac{1}{16}$ in. gap from the shoulder for pulling up tight. Cut the two webs as shown.

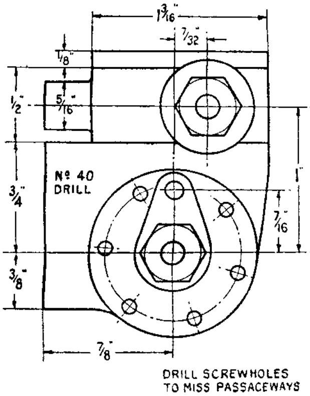
(*To be continued*)

Cylinders for "Tich"

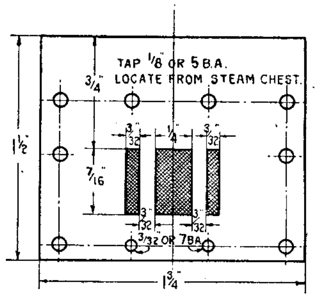
by "L.B.S.C."

BEFORE describing the cylinders for "Tich," may I take this opportunity of replying collectively to a number of letters that have come to hand during the last week or two, time of writing. It will save direct replies, and, I hope, further queries of the same nature. *I do not write, never have written, and have no intention*





Cylinders for "Tich"

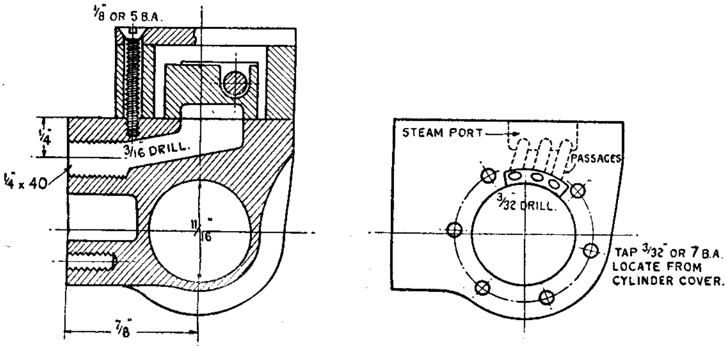


of ever writing any kind of article, in this or any other journal, under any other pen-name. When the late Mr. Percival Marshall, of blessed memory, invited me to become a regular weekly contributor to this journal, and tell the readers how to build locomotives that could do a job of work proportionately equal to that performed by their big sisters, I adopted as my pen-name, the letters L.B.S.C. "for luck," as you might say, being the initials of the old railway company. They are now known all over the world, coupled with the many locomotives I have built and described; and I wouldn't abandon them for all the tea in China, after using them for 25 years.

The reason for my correspondents' enquiries, is the fact that articles have appeared in other monthly and bi-monthly journals, under other pen-names, couched in a style similar to the one I use, and which I originated way back in 1924; I thought that readers would prefer me as a human being instead of an animated text-book, and so it proved. Success invariably brings imitators, and imitation is the sincerest form of flattery. Not only are my locomotive components and my construction methods pirated, but even my pet phrases such as "kiddies' practice job," "blobs and gadgets" and so on, find their way into "copycat" articles. As to new writers of this sort making claims that they can "improve" on my design and construction—well, it is a well-known fact that in any firm, the office boy of a month's standing, can always run the firm a jolly sight better than the managing director—'nuff said! That's that; and now, as a famous radio comedian frequently says: "Let's get on with it."

These cylinders differ slightly in detail from the kind I have hitherto specified, though the principles are the same. The bore and stroke, $\frac{11}{16}$ in. × $1\frac{1}{8}$ in., are suited to the equivalents of a full-sized locomotive of this type, and to the average steaming capacity of the little boiler. I might mention here, that bigger-bore cylinders may be used if desired, and I hope to describe an alternative boiler of larger size, circumstances and the K.B.P. permitting. However, "sufficient for the day is the evil [?] thereof," so we will see about these, first of all. There is no need to have an excess of metal in cylinders, so I have specified a steamchest just large enough to accommodate a slide-valve of suitable dimensions; and the bolting face of the cylinder castings may be recessed, enabling the cylinders to warm up quickly when starting from cold. As this recess is not open to the atmosphere when the cylinders are erected, cooling will be very slow. The ports are of ample size, and the passages drilled in accordance with my note on this subject some few months ago; they are large enough to pass easily all the steam needed, but

not large enough to cause waste, and produce a too-violent blast. The big slide-valves are driven by a long nut working in a slot in the back of the valve; the spindle of each goes through a U-shaped slot in the back of the valve near one side, and screws into the nut. No tail guides are needed; the long gland gives sufficient bearing surface to the valve-spindle, without any additional support, making it an easier job for beginners. The cylinder casting is long enough to allow of a piston $\frac{7}{16}$ in. wide, enabling a packing ring of $\frac{3}{16}$ in. square braided graphited yarn to be used. This is easily put on; much more easily than winding ordinary strands of yarn into the groove, and it works with little friction, whilst remaining quite steam tight. The oft-presented idea of a divided piston, with a groove which is filled with packing crushed tightly against the cylinder wall by screwing the two halves of the piston together, is what our transatlantic cousins would call "boloney." Pistons should be steam-tight, but not mechanically tight. You want the power delivered at the engine drawbar, not all mopped up in overcoming internal friction in the moving parts of the engine.



Steam and exhaust passage

How to Set Up the Casting for Machining

The following method is one which I have personally used ever since I first owned a lathe with a slide-rest, faceplate, and angle-plate. This, incidentally, was one of the first 3½-in. Drummonds ever turned out of the original shop at Rydes Hill, Guildford; it cost £13 10s., and was purchased on the "never-never," as my pay as a young fireman on the L.B. & S.C. Ry. wouldn't permit of cash purchase. This was about the turn of the century, nearly fifty years ago.

First, measure up the distance from the centre of the corehole in the casting to the bolting face and the port-face. If the former is more than $\frac{7}{8}$ in., and the latter more than $\frac{3}{4}$ in., you can start operations from the corehole, and save a lot of marking out and measuring; but if less, then the corehole is not true with the block, and provision must be made accordingly. Plug the corehole with a bit of wood at one end; scribe a line parallel with the bolting face at $\frac{15}{16}$ in. away, and one parallel with the port-face at $\frac{13}{16}$ in. away. Where the lines cross, is the true centre of the bore. Make a centre pop at the crossing, and scribe a circle from it, $\frac{11}{16}$ in. diameter.

Next, attach your angle-plate to the faceplate by aid of a couple of bolts. Smooth off the port-face of the cylinder casting with a file; no need for a posh job—you needn't touch it if there are no knobs or excrescences on it—just make certain it will bed down on the angle-plate reasonably flat. Then mount it on the angle-plate, just overhanging the edge, fixing it with a bar across its back, held down by a bolt at each end. Now a little patience is called for. If you are locating from the core-hole, set a scribing-block on the lathe bed, or put a pointed tool, or even a bit of pointed wire, in the slide rest. Now adjust cylinder casting and angle-plate, until, when the lathe belt is pulled by hand, the edge of the corehole runs truly. This can be gauged by applying the scriber needle or tool point to it. Gauge whether the casting is square with the faceplate, by applying your try-square to it, stock to faceplate, and blade to cylinder; see illustration. When the casting is square with the faceplate, and the corehole runs truly, it is set O.K., so the bolts can all be tightened up. Warning—don't overdo the tightening, and distort either the casting, the angle-plate, or both. You'd be surprised how even a heavy lump of metal will "spring!"

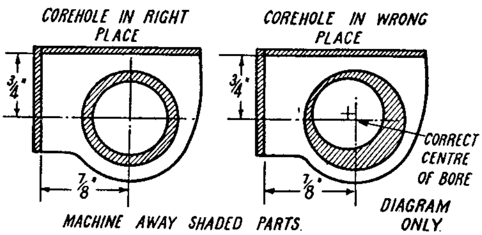
If locating from a marked-off centre, as mentioned above, all you need do is to run up the tailstock, with the centre point in it, and adjust the casting and angle-plate until the point will enter the centre-pop. Start the lathe; if it runs steadily, all well and good. If it rocks the workshop, as it most likely will, bolt a balance-weight to the faceplate directly opposite. I use an old circular cistern weight for a heavy casting, or one or two of my lathe change-wheels for a lighter one; anything handy will do.

Facing and Boring Operations

Set a round-nose tool crosswise in the rest at centre height, and take a facing cut right across the end of the casting, same as you faced the rims of the wheels. The amount to take off, is easily ascertained. Measure the overall length of the casting; from this, subtract the finished length, viz., 1¾ in., and turn away half the difference; thus, if the casting is 1⅞ in. long, it needs just $\frac{1}{16}$ in. turning off each end. Take a good cut, say a full 1/32 in. deep, at slow speed, to get the skin off the casting; if the tool rubs on the skin, the cutting edge will be dulled in a matter of seconds. The final cut should be just a skim, with the lathe running fairly fast.

Now set up your boring-tool in the rest. I use a boring-tool with plenty of top rake—

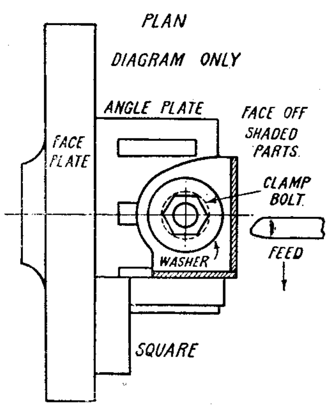
that is, sloped well back from the cutting edge—and set a little above centre, which precludes any chance of the lower part rubbing. Set your change wheels to move the saddle at the slowest possible speed (that is, as if you were going to cut the finest thread that the lathe would pro-



How to mark off cylinder bores

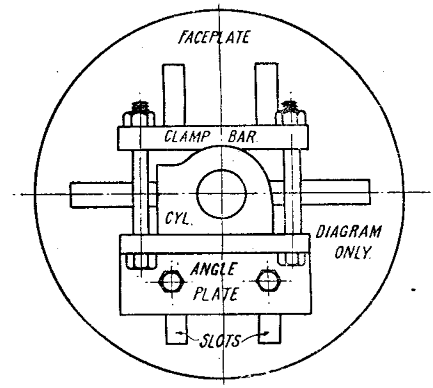
duce) and take a cut, at fairly slow speed, and about 1/32 in. deep, clean through the corehole. Another warning: if the corehole isn't true, and you have had to find the true centre, adjust the tool to cut deep enough to clean out the corehole completely; if it cuts one side and rubs on the other, away goes the cutting edge at once. Set your slide gauge or inside calipers to a shade under $\frac{11}{16}$ in., and ditto repeato the boring operation until the tips just enter.

But supposing we haven't a screw-cutting lathe, nor even a self-act, says a beginner; what then? Nothing at all to worry about! Before setting up the casting in the first place, put your three-jaw on the mandrel nose, with a piece of brass rod in it about ½ in. diameter, projecting about 2 in. from the jaws. With a round-nose tool in the rest, take a very slight cut, only a few



How to set up, and machine flat faces

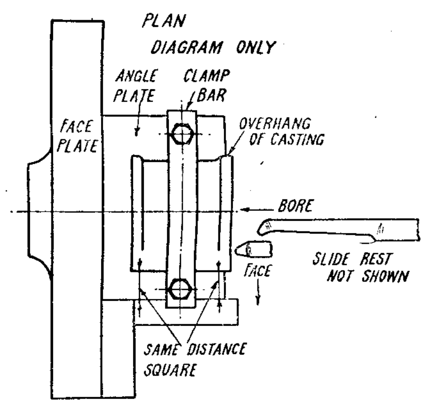
thousandths deep, along the rod. Gauge both ends with a micrometer or caliper gauge, or even an ordinary pair of calipers. If the "mike" indicates less than half a thousandth difference at each end of the cut, or if you can detect no appreciable difference in the feel of the calipers, the top-slide is set O.K. for boring. If there is a difference, simply adjust the top slide, have another go, and keep on by trial and error until you get the slide set right. Then set up your cylinder casting as above; and when boring, simply turn the top-slide handle very slowly, to feed the tool steadily through the bore. Simple enough, sure-lie, as they say in Sussex.



How to mount cylinder for boring

Reaming

If you haven't an $\frac{11}{16}$-in. parallel reamer, finish to size by boring only. Regrind the boring-tool, and give the cutting edge a rub on an oilstone, to make certain it won't scratch; then take out the final few thousandths in the same way as the boring operation. To get a posh finish, take the final two or three traverses of the tool through the bore, without moving the cross-slide; then,



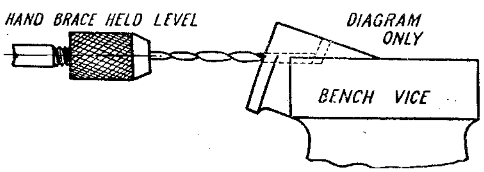
How to bore and face cylinders

when the tool ceases to cut, you should have a bore as smooth as glass, and perfectly true. I finished "Jeanie Deans's" big low-pressure cylinder that way, as I had no reamer as large as 1¼ in., and sometimes I finish a smaller one in similar manner, as my Milnes lathe bores truly.

To ream in the lathe, first make sure there is sufficient room between the cylinder casting and

the faceplate, for the full diameter of a parallel reamer to come through; if not, you'll have to ream by hand. If there *is* room, first make certain that the bore is all right for reaming. Try the "lead" end of the reamer in it; it should just enter nicely. If it won't, then take another cut through the casting with a boring-tool, until it will. A reamer is a finishing tool only; it isn't intended for removing a lot of metal, only just a scrape.

Now watch your step. Put a carrier on the reamer shank, and hold the reamer against the tail-stock centre, with your left hand. Grip the tailstock with your right, run it up to the casting, enter the end of the reamer in the bore, and with the lathe running at medium speed, push the reamer clean through the bore, as far as it will go, by sliding the tailstock bodily (and steadily!) along the bed. *Don't stop until you get to the end of the movement*; then reverse, and make a nonstop journey back again. This operation has never, in my own case, failed to produce a clean smooth bore. A drop of cutting oil on the reamer is a help; and it is advisable to rub your finger-nail along each cutting edge, to see



How to drill passages by hand

if there are any rough places to scratch the bore. If you find any, apply your oilstone along the edges. If the reamer is stopped at any point in the bore, the result will be scratches and rings, so be sure to make a nonstop run both ways. Make the reversing pause as short as possible.

If there is no room to ream in the lathe, do it by hand *after facing off the other end of the casting*. Catch the casting in the bench vice, put a big tap-wrench on the reamer shank, and carefully work it through by hand. When hand-reaming, it doesn't matter about stopping the forward movement of the reamer, if you stop turning it at the same time. Don't reverse the reamer, but when the flutes have passed right through the bore, take off the tap-wrench, and push the shank of the reamer right through. If you reverse, and "screw" the reamer out, it is a million dollars to a pinch of snuff that you will bell-mouth the end of the bore.

To face off the other end of the casting, put a bit of $\frac{3}{4}$-in. round rod in your three-jaw, and turn it down until the cylinder will just push on very tightly; if you have turned the crank-pins and wheel seats to press fits, that job shouldn't cause any worry! Then push the cylinder on, and face off the end by the same method as you faced off the first end; the total length over the flanges should be $1\frac{3}{4}$ in. If the cylinder slips on the mandrel, a bit of tissue paper between mandrel and bore, will teach it better manners without doing any damage to the finished surface.

How to Face the Flat Surfaces

Before I had a milling machine, I faced the flat surfaces of all cylinders by the following method, which I still employ sometimes, by way of a change. First of all, mark out on the finished ends of the cylinder, the limits of the port and bolting faces. The former is $\frac{3}{4}$ in. from centre of bore, so the distance between edge of bore, and port-face, will be 13/32 in. By the same token, as Pat would say, the bolting face will be 17/32 in. from edge of bore. Scribe the lines as shown, and you'll see how much there is to come off.

Now up-end the cylinder on the angle-plate, and hold it in position by a long bolt through the bore. Put a piece of soft metal, such as copper or aluminium, between faced end and angle-plate, to prevent marking; put another piece on top, a big washer on top of that, and finally the nut. Adjust the angle-plate so that the cylinder is as near the centre of the faceplate as you can get it; then set the bolting face right for machining, by putting your try-square with the stock to the faceplate, and adjusting the casting until the line indicating the port-face limit, is level with the blade. Tighten the bolt; and with a round-nose tool set crosswise in the rest, face off the bolting face until you reach the marked line. Check with slide gauge or caliper, making sure the bolting face is exactly 17/32 in. from the edge of the bore.

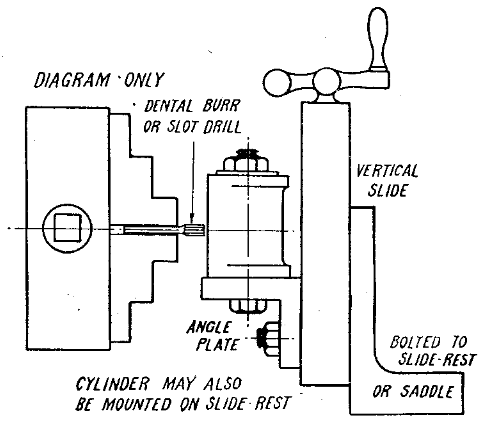
Slack the bolt, and slew the casting around a quarter turn, to bring the port-face right for machining off. This time, set truly by applying the stock of your try-square to the faceplate, and the blade to the machined bolting-face. Tighten the bolt again, and tool off the port-face until it is exactly 13/32 in. from the edge of the bore. Both faces should now be exactly at right angles to each other, also at right angles to the ends of the cylinder, and both should be parallel to the bore, which itself should be perfectly true.

How to Cut the Ports

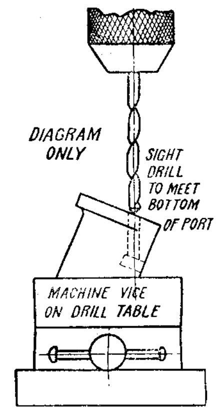
The easiest way I know of cutting long smooth straight ports, is by aid of a dental burr. The way these little instruments of torture walk through even hard cast-iron, is just nobody's business; no wonder they give you a "two-penny one" when you are in the operating chair! I don't know how things go under the National Health Service; but at one time, dentists used a fresh one for each client (my friend did, anyway) and then threw them away. I could get all I required, merely by asking; and all they needed, were the remnants of tooth brushed out of the flutes with a wire brush, and they were all set to cut several sets of ports. I use them in a Wolf-Jahn precision vertical milling machine, but they can be used in the lathe, just as well, as described below.

The first job is to mark out the location of the ports; and to make the lines stand out like those at Crewe on a sunny day, coat the port-face with marking-out fluid. A good one can be made by dissolving some shellac in methylated spirit, and adding a little blue or violet aniline dye or other colouring matter. This applied with a soft brush, dries in a minute or so;

and any residue left after the job is finished, can be rubbed off with a rag wetted with spirit. The location of the ports is given on the accompanying illustration, and all you have to do is copy it. The two steam ports can be cut with a dental burr, and the exhaust port with a $\frac{1}{4}$-in. slot-drill, made as previously described in "Beginners' Corner." It doesn't matter a Continental about the ends being left rounded; many big engines' ports have rounded ends. If you can't get a dental burr, make a weeny



How to end mill ports



How to drill passages on drilling machine

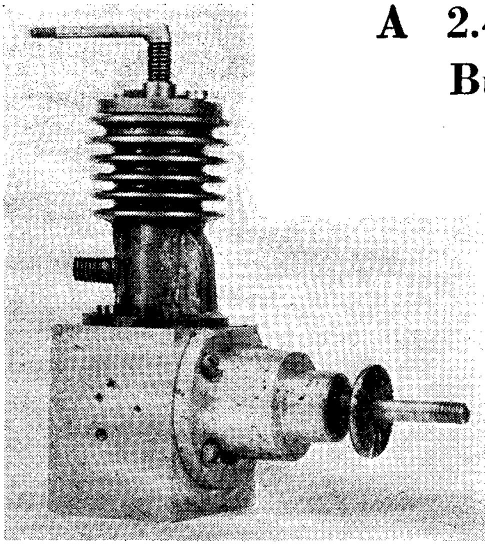
slot-drill from a bit of 3/32-in. silver-steel, or else cut the ports by hand, as explained later.

Put the dental burr or slot drill in the three-jaw. If you have a vertical slide, bolt the angle-plate to it, and mount the cylinder end-up on it, in the same way as when machining the port-face. If you haven't a vertical slide, clamp the casting to the saddle or slide-rest, packing it up so that one of the marked-out ports is level with the cutter. Then run the lathe as fast as you can, without causing an earthquake. Feed the casting on to the cutter, by moving either the top slide or the saddle; let the cutter enter about $\frac{1}{16}$ in. and then traverse the casting across the cutter by aid of the cross-slide. Warning: don't "overshoot the platform" and make the ports too long. Beginners can easily fix a temporary stop on the cross-slide to prevent overrunning; the kind of stop depends on what type of lathe you have. Some lathes only need something like a toolmakers' cramp clipped on the slide. Cut the port to about $\frac{1}{4}$ in. depth; if you use a vertical slide, you only have to turn the handle, to bring up another port ready for cutting; but if not, you'll have to adjust the height with packing. Use the $\frac{1}{4}$-in. cutter, naturally, for the exhaust port.

To cut ports by hand, drill a row of holes down each marked-out steam port with a 5/64-in. drill, and 7/64-in. for the exhaust port. Then make a couple of weeny chisels, one from $\frac{1}{4}$-in. silver-steel, and one from 3/32-in. ditto. Just file to shape, harden and temper, same as I described for the slot-drills, etc., and give each a rub on the oilstone. With these, a light hammer, a bit of "common savvy" and the bench vice, you will find it easy enough to chip each row of holes into a rectangular port. Don't drill the holes more than $\frac{1}{4}$ in. deep; in fact, they only need be deep enough to meet the slanting passageways coming up from the bore, and the exhaust passage.

How to Drill the Passages

On the centre-line of the bolting face, at $\frac{1}{4}$ in. below the port-face, drill a 7/32-in. hole about $\frac{3}{8}$ in. deep, and tap it $\frac{1}{4}$ in. by 40. To connect this with the exhaust port, you can either poke a $\frac{3}{16}$-in. drill into the end of it, canting upwards, and drill up into the port, or put the $\frac{3}{16}$-in. drill down the port, drilling through the bottom corner until the drill breaks into the tapped hole. The other holes are a little more tricky. What I usually do, is to make deep centre-pops close to the bore, then put the drill in my drilling machine, and the casting in a machine vice, end up, sighting it with the drill outside the casting, and slanting same in the machine vice until the drill forms a line from the lip of the bore, to the bottom of the port. I then go right ahead, knowing that the drill will break into the bottom of the port. This, however, would be awkward to emulate on a lathe, because the machine-vice and casting would have to be held by hand against the drilling-pad; so if you have no drilling machine, do the job by hand. Simply catch the casting in the bench vice, but hold it at such an angle that the drill, if the drill brace is held horizontally, will go straight from the centre-pop at the edge of the bore, to the bottom of the steam port. Very important tip, this—grind the drill slightly off centre (that is, with one cutting edge longer than the other; I might add that most beginners do this automatically!) and the drill will then cut a bigger hole than its diameter. If you are unlucky, and break it, the bits are easy to get out. The fatal moment is just as the drill goes through into the port. Whilst drilling through the solid metal, withdraw it every $\frac{1}{8}$ in. or so, and clear the chips off.



A 2.4 c.c. C.-I. Engine Built from Scrap

by P. J. Tucker

THE 2.4 c.c. compression-ignition engine here described was built entirely from odd pieces of metal, for the main purpose of acquiring some practical experience of a type of unit which, I think, has a peculiar fascination about it. If there are any enthusiasts who have been scared by what they have read about the difficulties of achieving any sort of success, let them just forget all about it.

I found this engine no more difficult to make than the excellent petrol jobs described by Mr. Westbury, and anyone who cares to follow this brief description, should be able to achieve success at the first attempt.

So long as the important dimensions are adhered to, you can please yourself about the externals, as it will be noted that my crankcase has no means provided for bolting the engine down. As I have said, it was built for running on the bench, and not for fitting into a plane, boat or car.

The crankcase was machined from a block of duralumin which I had used for years as a block on the drilling machine, and it still bears evidence of its previous duty. After the block had been squared up truly on all its faces, it was marked out for the main bore and the cylinder-spigot bore, the dimensions of which are given in the drawings.

I used a four-jaw chuck for all operations on the block, and as it had been machined all square, I was assured that the cylinder axis would be at right angles to the crankshaft axis, which is important.

It will be found that a thin wall is left between the main bore and the cylinder-spigot bore; this is chipped away with a chisel and the final clearances for the connecting rod made with a file, which is also used to make the transfer-passage connection.

The holes for the 6-B.A. screws which secure the cylinder and the main-bearing housing, are left until the cylinder and housing are made, being marked off from the holes made in these components.

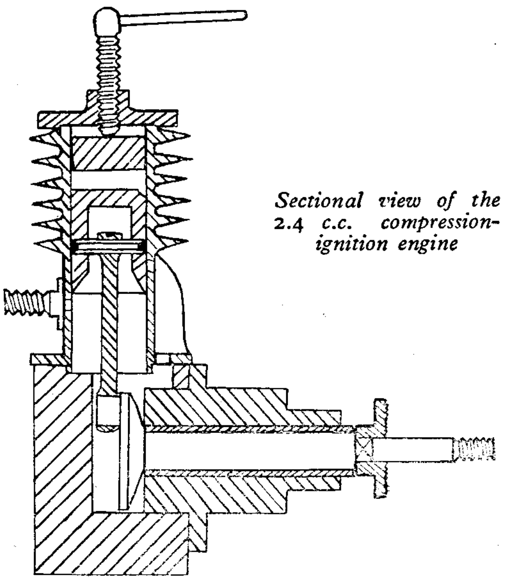
The main-bearing housing can be machined from a round bar of light metal. As the largest diameter is 1½ in., a bar of this size can be used, as the dimension is not critical.

For the bearing I used a valve-guide taken from an Austin Seven engine as I planned also to use an Austin Seven valve for the crankshaft. The idea proved quite practical, and moreover, neither the bore of the guide nor the valve spindle needed any attention from me, although they were far from new.

One drawing of the crankshaft will show how the valve was treated, but I must warn anyone who follows this idea that the material will probably be found exceedingly tough. The crankpin is of silver-steel silver-soldered to the web with "Easyflo." It will be noted that no attempt was made to balance the crankshaft.

In point of fact the engine runs with a remarkable absence of vibration. I have a well-known commercial engine of the same capacity which is almost "unrunable" even when its mounting is held in the vice. There is nothing mechanically wrong with it, but the vibration makes the engine useless and it cost just under £5!

I have made cylinders by various means, such as brazing-on bolting-down flanges, shrinking-on cooling fins and so on, but I have found that the most satisfactory way is to machine them from



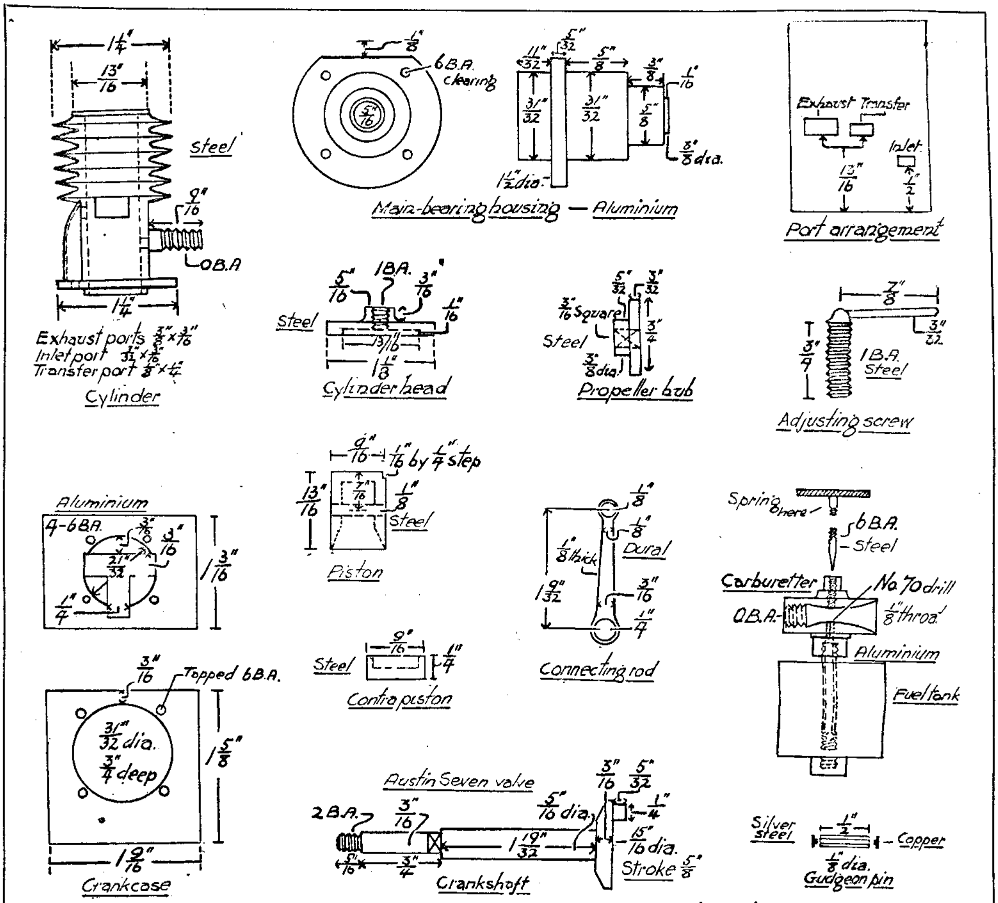
Sectional view of the 2.4 c.c. compression-ignition engine

the solid bar. After all, it is a straightforward turning job, as with a compression-ignition engine, the transfer-passage cover, and the nipple for the carburettor can be soft-soldered on with safety.

The vital consideration is the bore and the fit of the piston in it, and this is where I go my own

Do not be afraid to scrap one, however, if you do overdo things, because it is next to useless to proceed unless you have a piston that does really fit.

To drill the gudgeon-pin hole, I mark off the position in the lathe using a home-made



Details of the components for the 2.4 c.c. c.-i. engine

way. I finish the cylinder bore fairly well with a crude sort of lap consisting of a split length of wood around which I wind emery paper. This is run at the highest speed I can get on my lathe, and the cylinder moved backwards and forwards over it.

Having got so far, I make the piston, and in the present instance this is of silver-steel. It was turned a few thous. oversize and using an outside lap it was gradually brought down to size.

You really need a micrometer which reads to 0.0001 in. as it is not sufficient to guess 1/10th between the 0.001 in. readings of the usual micrometer. Assuming that the piston reads dead true throughout its length, but is still oversize, leave it alone and lap the cylinder. I ring the changes in this way and find I have to scrap but few pistons.

division plate. Having centre-popped the piston each side, I transfer the piston to the drilling machine and take the drill in from each side. The hole is brought to size by using a reamer made from silver-steel of the same diameter as that used for the pin.

Duralumin is used for the connecting-rod, a short length of rod being marked off, centre-popped, and drilled undersize in the drilling machine. The holes are brought to size by using reamers made from silver-steel of the same diameter as the gudgeon-pin and crankpin respectively.

I do not think I need deal with the other bits and pieces individually, as the dimensions of them are all given in the drawings.

If the engine is to be used with a propeller, the square-holed driving disc should be well

ridged by means of a three-cornered file, as I have experienced a lot of trouble in keeping the propeller secure when flicking it over against the high compression.

I have found this engine will run on many different fuel mixtures including Mercury, Mills Blue Label, N.M.S. Blue Label, and several mixtures of my own.

In my experience, I have found that an engine which takes an undue period of time to get going will start almost immediately if a drop of fuel is injected via an exhaust port. A degree of control over the revolutions is possible by moving the contra-piston control in conjunction with the fuel-metering screw. More fuel, less compression, and vice versa.

Should the engine persist in the phenomona of running backwards, stop it at once and start up again after reducing the compression. It is a good idea to fit a drain screw in the base of the crankcase as this saves turning the engine on its side to drain off excess fuel from the exhaust ports.

Another important point is that if the flywheel or propeller are not suited to the engine, it may refuse to run. The propeller on the engine here dealt with is an 11 in. Trupitch. If possible, avoid securing the propeller by the two-pin method. I have found that the holes required by the pins cause the propellers to split—quite an unpleasant experience at times.

With the Editor's permission, I should be pleased to demonstrate this engine to anyone living within reach of Croydon, Surrey, or to supply any further information regarding it.

For the Bookshelf

Handbook of Perspective. (Third revised edition.) By W. G. Warren. (London: Crosby Lockwood & Co. Ltd., 39, Thurloe Street, S.W.7.) Price 10s. 6d.

This book deals with the subject of perspective from its fundamental principles, in such a way as to cover all essential requirements in architectural and other forms of drawing, but without elaboration of detail which would be more likely to confuse than to educate the elementary student. It begins by a section on general principles, geometry, and methods of setting out, followed by sections on horizontal and inclined centres of vision, reflections, shadows, curves, and aids to construction of perspective drawings.

Modelmaking for Boys. By H. S. Coleman. (London: The English Universities Press Ltd., St. Paul's House, Warwick Square, E.C.4.) Price 5s.

Many books have been written on models for juvenile construction, and the majority, it must be confessed, have failed in their purpose for various reasons, one of the most common being the optimistic belief that what looks simple on paper must necessarily be simple to construct. The light-hearted sweeping away of very real practical difficulties is not at all helpful to the beginner, and it is by no means easy to devise either model designs or ways and means which are at once attractive and practicable for the youthful beginner. In this book, it may at least be said that many of the worst pitfalls are avoided, and the psychology of the prospective reader has been studied. So far as non-working models in wood and similar materials are concerned, the claim that the work is within the capacity of the intelligent beginner with very limited tool equipment, is probably justified. But mechanical models present much greater problems, and it often takes a much more skilful hand to construct the "simple" model than is realised by its designer. Plans and instructions are given in this book for a toy sailing yacht, a miniature galleon, a beginner's marine steam plant, a waterline model liner, a flying model cabin monoplane, and a solid scale model air liner. Taken by and large, the book can well be recommended as a Christmas present for a youngster with a flair for mechanical craftsmanship.

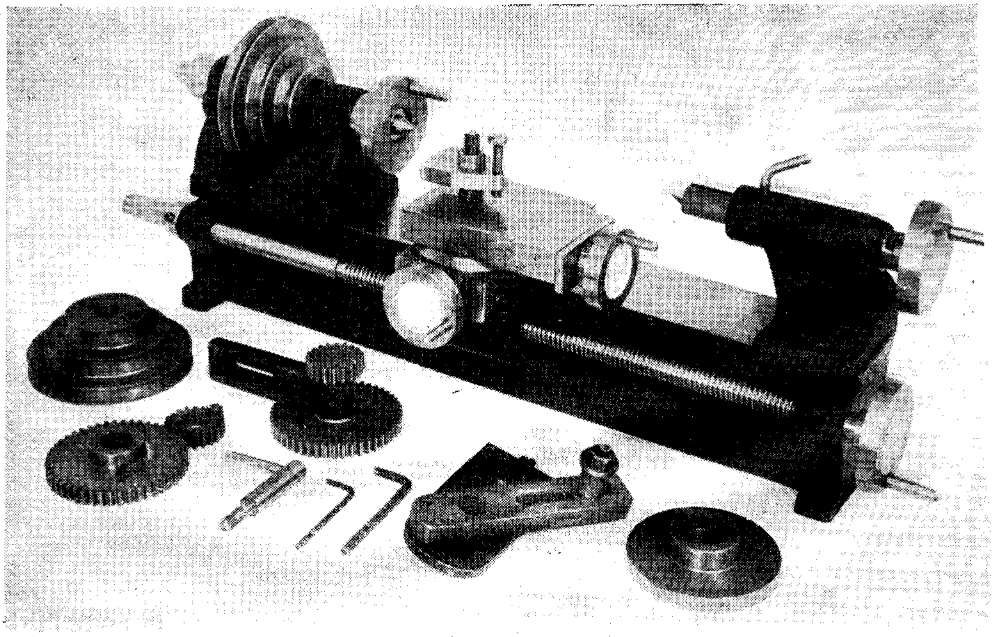
In the Workshop. (Volume 1.) By "Duplex." (London: Percival Marshall & Co. Ltd.) Price 8s. 6d.

Readers of THE MODEL ENGINEER will need no introduction to this book, which consists of a selection of articles which have appeared in THE MODEL ENGINEER under the same title, by a team of two authors whose practical ability and experience are beyond question. The present volume contains chapters on lathe chucks, tool equipment for the lathe, knurling, test indicators, indices, drilling, spot facing and counterboring, formation of flat surfaces, etc. Among the attractive features of the book are the illustrations, which consist of 127 clear and bold line drawings.

Models in Wood. By C. Baker. (London: Percival Marshall & Co. Ltd.) Price 7s. 6d.

Although timber is at present one of the many things officially described as "in short supply," the small quantities likely to be required by the model maker are probably as easy to obtain as most other materials, and wood is quite legitimately adapted to many purposes in model engineering. Given a fairly sound elementary knowledge of general woodworking principles, the special technique of wood modelling is readily acquired with practice and the tools required are simple and inexpensive. The author of this book is clearly well qualified by practical experience to explain the methods employed in constructing various types of models, such as model ships and aircraft, miniature coach building, including railway rolling stock, furniture and various types of static models. The use of plywood and veneers is discussed, and finishes appropriate to the particular purpose are described. Model engineers will appreciate the eminently practical treatment of a subject on which little specific information has hitherto been available.

The "E.W." Convertible Lathe



THE idea of a lathe which can be produced in a basically simple form, and improved as the need arises, and as resources permit, by the addition of extra fittings and equipment, is by no means a new one to readers of this journal. It has been suggested and discussed in these pages on many occasions, and attempts have been made to put it into practice by several manufacturers, with varying degrees of success. Although the advantages of such a lathe, to model engineers with limited means and facilities, are beyond question, its design and production are by no means as simple as they appear, and it may well be that it turns out in actual practice to be more complicated and expensive than a lathe designed as a complete and more or less immutable unit; or it may become a kind of patchwork creation, with odd bits stuck on as afterthoughts. For the practical success of such a lathe, much care and forethought in the design are essential, and it must be produced to close limits, so that all parts are interchangeable, and any equipment added subsequent to the date of purchase can be guaranteed to fit and work properly; all of which are in some degree incompatible with inexpensive production.

The lathe illustrated here is described as "convertible," though the term does not seem quite appropriate to describe the type of lathe which fulfils these conditions. It is obtainable as a "plain" lathe, having a direct-drive mandrel, screw-feed tailstock, and compound slide-rest, to which may be added a simple form of back gearing, and/or complete screw-cutting gear, comprising a leadscrew and apron, with solid but detachable nut, and a full set of change-wheels. The leadscrew is provided with a handwheel so that it can be used for traversing, with the entire saddle sliding on the bed.

The lathe is of $2\frac{1}{2}$ in. centre height, without gap, and admits a maximum length of 8 in. between centres. Several interesting and ingenious features are incorporated in the design, including a form of bed which assures accuracy and rigidity without excessive weight or complicated casting, and a headstock made in two separate units, which are machined in a form of jig which ensures uniformity and correct alignment, the same jig being used to bore the tailstock. All three components are attached to the bed by gripping over the edges of the shears. The mandrel journals are $\frac{5}{8}$ in. diameter, and run direct in the cast-iron housings; a hole 13/32 in. diameter is bored right through the mandrel and tapered No. 1 morse at the nose end. A self-ejecting form of tailstock barrel, also having a No. 1 morse socket, is fitted. The slide-rest is fully compound, with swivelling top-slide having a circular base calibrated in increments of 5 deg. A further refinement is the provision of handwheels graduated in 1/1,000 in.

The back gear attachment comprises a bracket which can be mounted on the back of the outer headstock casting, and carries a shaft with a

(*Continued on page* 737)

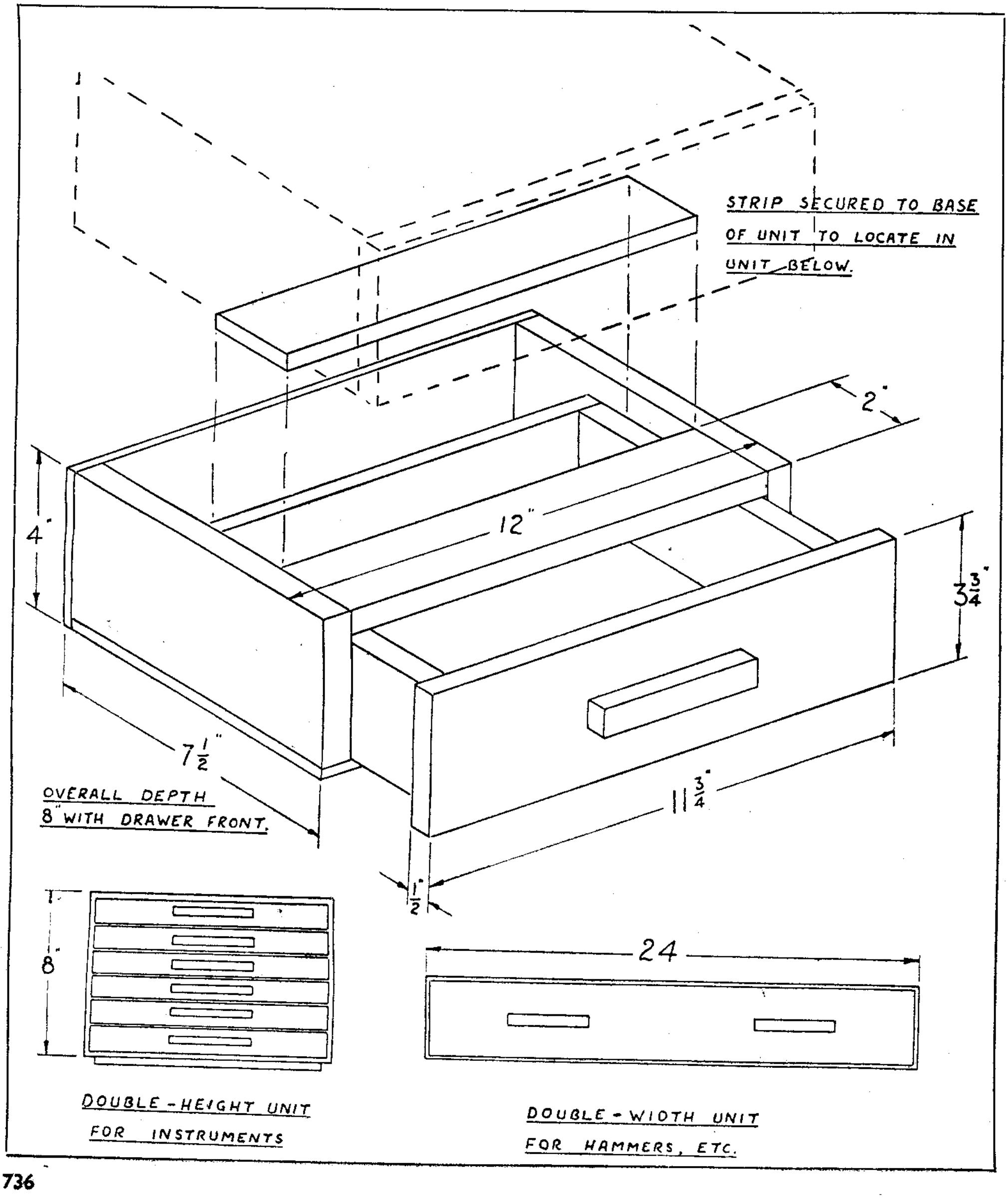
Unit Fixtures for the Workshop

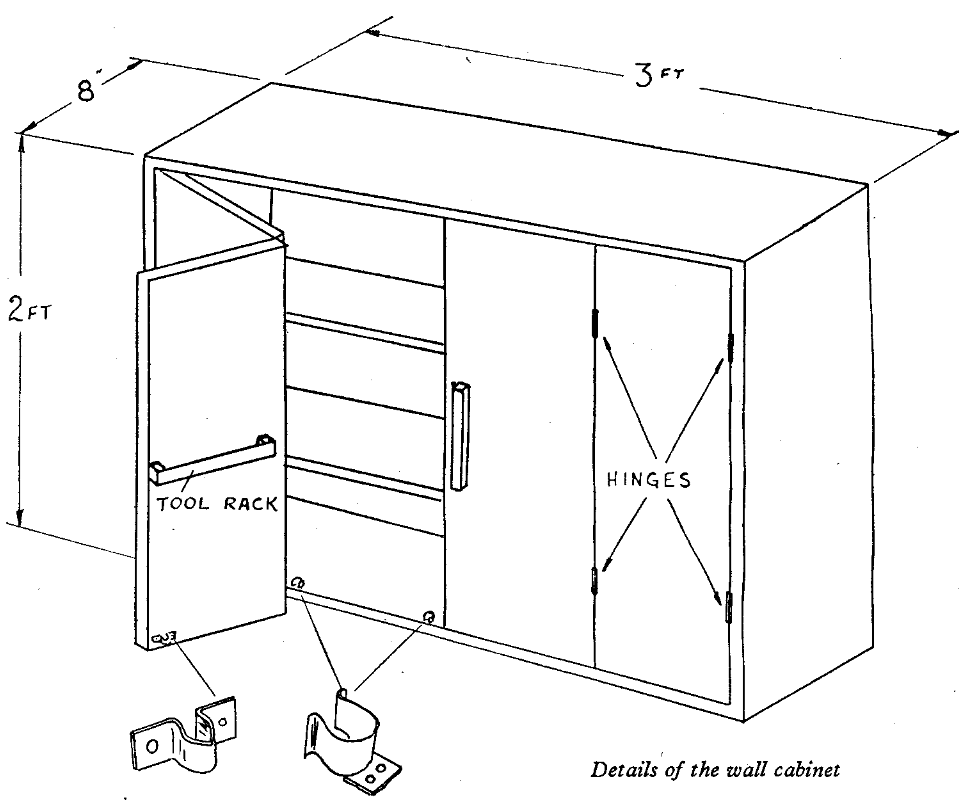
by E. R. Hooker

THE problem of storage for an ever-increasing and changing collection of instruments, small tools and odds and ends was settled by designing " unit " storage boxes which could be added to as required, rearranged as desired and would be easily transported in case of a move.

The sizes shown in the sketch will be found suitable for most purposes but obviously can be altered to suit individual requirements. As the writer is a poor cabinet-maker, the drawer fronts were made to cover the whole unit so that joints are not seen. This also allows for the use of any thickness of wood—my own were built from orange boxes and such scraps as I could collect.

Butt-joints glued and nailed will be found quite satisfactory but the drawer handles, shaped as





Details of the wall cabinet

required, should be fixed with countersunk screws from the inside of the drawers. Drawers to contain instruments have partitions shaped to take them, each partition lined with odd pieces of felt, glued in position and soaked in oil.

Labels denoting the contents are a great time-saver and the letterpress machines on railway stations give good value at twenty-two characters for a penny. Incidentally, it is best to stamp all the labels out in one long strip leaving about three or four letters gap between each name and shaping the labels in the workshop. I labelled all my units for about a shilling.

Double-height or width units may be found useful for some tools and I have one double-height unit with no drawers which houses my three drill stands, also, one which houses twenty cigarette tins (happy days) of the fifty type which contain B.A. nuts, screws, spring washers, etc.

I have also built two wall cabinets. These fit in with the other units, one housing lathe equipment and the other carpentry tools. The doors of these cupboards are hinged in two places so that there is less overhead interference when the doors are open, the most frequently used tools being kept in the centre. The doors are kept shut by spring fasteners which are obtainable from any multiple store. The cabinets are screwed through their backs directly to the wall.

If these units are painted a light stone colour with the handles black or green, they will be found to give a very tidy appearance to the workshop, as well as being an excellent way of containing the assortment of items found therein.

The "E.W." Convertible Lathe

(*Continued from page* 735)

wheel and pinion attached. This works in conjunction with a pinion fixed to the three-step driving pulley (which is released from the mandrel when the back gear is engaged) and a large spur wheel mounted on the end of the mandrel. Either in the basic form, or with its added equipment, the machine sells at a competitive price, and will undoubtedly be attractive to readers who wish to equip their workshops as economically as possible.

MAKING NAME-PLATES

by W. J. Hughes

It is not claimed that this method of making name-plates is new—far from it—but it does not appear to be as widely known among our fraternity as it deserves, in view of the fact that so many models need name-plates.

One of the drawbacks to cast name-plates is that tiny sizes of pattern-makers' letters are not available, and even if they were, the definition of the letters when cast would be poor, because of the grain of the moulding-sand. Even the finest sand has its limitations; "you can't scale nature!"

As for the plates one often sees in which the letters have been punched, in many cases these are out of character, because the letters are *sunk* in the surface, instead of being *raised*—it isn't often that prototype name-plates have sunk letters. Again, with punched letters, the smallest size available is $\frac{1}{16}$ in.

With both cast and punched plates, too, we are limited to certain styles or shapes of letters, but with the method about to be described, this does not apply.

In fact, with this method, none of the above drawbacks apply—the letters can be of any size (almost microscopic, if you like); they can be raised above the surface or sunk in it, and the shape can be what you will—block, roman, italic, cursive, or any other style. As for a neat border with or without fixing tags, this is child's play.

Briefly, all you have to do is to draw the name-plate *in reverse* (a mirror image, in other words), and take it to the local maker of printing-blocks, who will do the rest. If you don't know where to find a block-maker, any printer can tell you, or the local Chamber of Commerce will know.

The block-maker will photograph your drawing, and print it on the surface of a zinc or copper plate (whichever you prefer). The plate is then immersed in acid, which eats away the surface except in the places which were black on your drawing. When the etching away is completed, of course, the letters, borders and anything else which you inked in will be raised above the background. The plate(s) may now be plated chromium, silver, or even brass if the prototype was brass, or may be left zinc or copper.

Drawings for three pairs of name-plates prepared by the author, as described in the text

Tiny Lettering

The beauty of this idea is that you can make your original drawing any size you like, and the block-maker can reduce it to any desired size. Supposing, then, you require letters only 1/32 in. tall, which in the ordinary size would be difficult to draw, you can make your original four times or even eight times the size, so long as any other lettering is proportonately enlarged, and so long as you tell the block-maker to reduce it by four or eight times.

Reversal

The reason for making your original in reverse is that the process used will reverse it back again, since it is the normal process used in making a line printing block, such as are used in printing the line-drawings in this journal. I give herewith some examples of drawings for nameplates, and it will be obvious that on the *blocks* from which these drawings were printed, the names will *not* be in reverse.

Final Hints

It is recommended that, in any event, you work to two or three times the finished size in preparing the drawing, for in the reduction any small fault will be made doubly or trebly small. If the prototype allows it, plain block lettering is desirable, and as you work keep a small mirror handy—yes, that one out of the missus's hand-bag

is ideal. A fine mapping-pen or drawing-pen is best for the inking-in.

Spacing Letters

A point to note is that the spacing between letters is not always equal; otherwise it looks unequal, the human retina being what it is. As an example, take the name-plate " CHIQUITA." The space between C and H is slightly less than between H and I, because C is an " open " letter, and the eye takes in part of the white space embraced by C, as well as the *actual* space between C and H, thus making the two spaces *appear* equal.

The spaces between I and Q, Q and U, and U and I are equal to that between H and I, but between I and T the actual space is reduced again, because T is an open letter. On the other side, between T and A, the *actual* space is cut out altogether, because *both* these letters are open.

Other open letters where the intervening spaces need similar adjustment are E, F, G, J, K, L, P, S, V, W, X, Y and Z.

One small snag with this method of making plates is that if you want a pair of plates, you must prepare a pair of drawings, unless you are prepared to pay more. However, this not need take long if you are using block letters—as an example, I recently drew out four pairs, including the three pairs shown, in two hours.

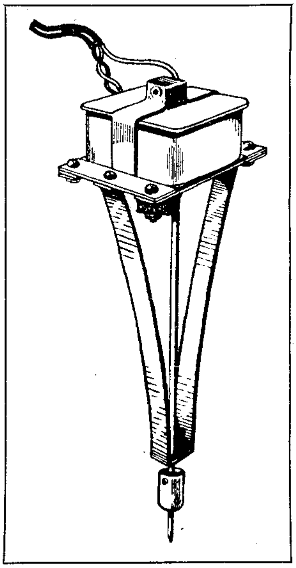
Cost

The cost of the plates in zinc works out at slightly under one shilling per square inch, *but* the minimum area charged for is 14 sq. in. at 13s. 7d. (time of writing). This means that you can have quite a few nameplates done for the minimum charge One solution is to slip the name-plates in with some larger order for another purpose, and if you can get round the block-maker, he may be prepared to do this for you. Another alternative is to join with several club-mates who are requiring plates, or who *will* be requiring them in the future. Nothing like looking ahead!

Finally, do not ask the maker to separate the plates—he will charge you 1s. 4d. each for this; simply allow sufficient area between each for you to cut them apart with a fine saw and to trim the edges with a file. On the other hand, don't leave too much area between them, because this will cost you money, too!

The " Juneero " Electric Engraver

THE makers of the well-known " Juneero " constructional kits have recently introduced a design for a vibratory percussion engraver which can be worked from the 200-240-volt a.c. electric supply mains. All the metal parts of this device can be made from " Juneero " standard materials, including nuts and bolts, and the solenoid coil is obtainable ready wound.



This particular type of engraving tool does not incorporate any form of contact-breaking device, such as is normally employed in engravers designed to run on batteries or d.c. mains. The vibrator element is in the nature of a reed, which is tuned to vibrate at the frequency of the a.c. mains, and can be adjusted to produce maximum amplitude when engraving hard materials, or to reduce the impact when working on soft materials. A rod attached to the centre of the reed transmits the vibration to the engraving tool, which consists of an ordinary gramophone needle, held in a sleeve coupling and readily renewable when it becomes blunt in use.

Tests of an engraving tool made to this design have convinced us that it is quite a practical appliance, and fully capable of doing useful work on any small objects which require marking. Some skill in handling is, of course, necessary in order to produce neat work in this way, but after practice, it is hardly any more difficult to manipulate than a fine mapping pen.

Handling may be made more comfortable by slipping a piece of thick rubber tubing over the lower end of the guide frame.

Anyone familiar with the working of " Juneero " materials will find it quite easy to construct this appliance, and the electrical part of the work is of the very simplest nature. It is important that it should on no account be connected to d.c. electric mains. All materials required can be obtained from " Juneero " stockists or from Juneero Ltd., Stirling Corner, Boreham Wood, Herts.

The Colouring of Metals

by D. Birchon, L.I.M., Silver Medallist C. & G.

FROM time to time most model engineers want to colour small metal components, and it is hoped that the following notes may be of interest in this connection. No originality is claimed for any of the methods given, but the sources of information may not readily be available to all. As far as is known, attention has been drawn to patent rights where necessary.

Two different metals in electrical contact can rarely be successfully tinted, due to electrochemical phenomena. With this proviso, the following general remarks refer to all the processes given :—

(*a*) The work must be polished with fine abrasive papers, not buffed or mopped. The higher the initial polish, the better the final lustre.

(*b*) The surface must be thoroughly degreased. On no account should petrol or paraffin be used, or the final colour will be streaky. Rub the work well with cotton-wool swabs soaked in carbon tetrachloride (CCl_4), removing the liquid with dry swabs or clean blotting paper, before the solvent evaporates. Repeat the treatment two or three times with fresh swabs. Any of the commercial cleaning fluids will do this work well if you are unfamiliar with CCl_4.

(*c*) Handling may be effected only by clean tongs, or better, supporting the work by wire(s) of the same material—attached before cleaning—at a point where any slight variation of colour will not matter. For batches of small articles, a wire basket is best, ensuring that all get precisely the same treatment and hence develop the same colour.

Plain carbon steels respond well to the following processes ; an experiment is usually necessary to obtain the desired result with alloy steels.

Heat Tinting : When a piece of steel is heated in air to 225-325 deg. C., the thickness of the oxide film formed is less than the wave length of light, giving rise to the well-known " temper-colours," varying from straw through brown and purple to blue. For an even tint the work must have free access to air, and be at an even temperature. Hence, heating the work on a sand bath is better than using a direct flame. When the desired effect is achieved, dip in thin oil to add lustre and improve corrosion resistance. This method is of course well known to everyone.

Spring Blue : This is the colour most often required, and the following method—which may be modified to give the other temper colours if desired—is a better way of getting it. A salt bath is required, composed of equal parts of sodium nitrate and potassium nitrate melted together in a clean dry iron pot. Add about a teaspoonful of manganese dioxide to each half-pint of bath when molten. Melting at 225 deg. C., this bath may be used up to 550 deg. C., at which it is just beginning to glow red in a darkened room. Under no circumstances must a drop of water be allowed to splash into the bath. The correct temperature for " spring blue " is 325 deg. C., and if you possess an accurate thermocouple or thermometer this will be simple. An equally good control is to immerse several pieces of steel in the bath and adjust the temperature to give the desired colour. The higher the temperature, the darker the blue. Dip the work in hot, light oil, drain and immerse in the salt bath for about two minutes. Cast-iron may be similarly " blued " if immersed for about fifteen minutes.

Brown : Immersion in a solution of ⅛ oz. of ammonium sulphide in a quart of water at 20-30 deg. C. (70-80 deg. F.) produces a brown coloration.

Black : Three methods may be used :—

(1) Place the work in a covered steel pot and heat to about 400 deg. C.—a piece of zinc which melts at 419 deg. C. is a good guide. When at temperature, admit a little linseed oil and agitate for five minutes, remove, cool and dip in oil.

(2) Make up a solution of :

Caustic soda	¾ lb.
Sodium nitrate	¼ lb.
Water to one pint.	

Add the caustic soda to the water in a basin piece by piece, and when wholly dissolved, add the nitrate. Treat the solution with the greatest respect, and use it out of doors or near an open window. The liquid may be kept in thick-walled glass bottles, although it will attack the glass. Use the solution boiling, adding fresh cold water carefully through a pipe which dips *below* the surface, to maintain the temperature at 130-140 deg. C. Immerse the *dry* work for ten minutes, remove, cool and dry—e.g., with methylated spirits—and dip in thin oil.

(3) Use a solution of :—

Nickel ammonium sulphate ..	1 oz.
Zinc sulphate	⅛ oz.
Sodium thiocyanate	⅛ oz.
Water to one pint	

Use a potential difference of one volt, adjusting the distance between the work and the nickel anode (connected to positive) to give a current density on the work of about 5 ma/in.^{2} The process results in a deposition of " black nickel " on the work, considerably enhancing the corrosion resistance.

Oxidised Copper Finish : The solution required is :—

Potassium sulphide	⅛ oz.
Water to one pint.	

Immerse the dry clean work in the above solution at 20-25 deg. C. (70-80 deg. F.) for a few minutes, remove and dry.

Mottling : Thoroughly mix 5 per cent. of crushed charcoal with some spent carburising compound, and pack the work into this mixture, sealing the iron box with a refractory cement (ordinary fireclay mixed with shredded asbestos

to minimise cracking is good enough). Heat to 650 deg. C. for 30 min. If you do not possess a thermocouple, use a piece of pure aluminium, which melts just below 660 deg. C.; beware of using aluminium-silicon which melts at 570 deg. C., or a similar alloy. On completion, remove the work and quench in thin oil. If the charcoal is replaced by potassium cyanide, brighter colours are produced. Naturally, heat treated plain carbon steels are softened, but the above method may replace the tempering operation with 3½ per cent. nickel and similar steels.

Commercial Surface Treatments: These are generally used to enhance the corrosion resistance, and provide a "key" for paints and enamels.

Phosphating Processes: There are many of these, Coslettising, Parkerising, Bonderising, etc., which produce a coating of iron-manganese-phosphate on the work. This surface has a high oil retentivity, and great corrosion resistance, combined with surprising resistance to wear. In applications on piston rings, tappets, etc., an increase in life of 50-100 per cent. has been claimed. An early Coslettising process used a solution made by allowing 1 per cent. phosphoric acid to react upon iron filings, and adding 0.5 per cent. of manganese dioxide. The resulting solution is used just below boiling point for thirty minutes, then the work is removed, rinsed, and dipped in light oil, or sealed in a chromate solution if it is to be painted. Despite the slight increase in thickness of about 0.0002 in., I feel there may be a use for these processes on small i.c.e. cylinders. Has anyone tried it?

Aluminising: Commonly called Calorising; the work is heated with aluminium dust in an atmosphere of hydrogen, to give a coating of aluminium alloyed to the steel. Another method is to spray the work with aluminium and heat treat at 900 deg. C. This is an excellent finish for heat treatment boxes, etc.

Sherardising: This highly successful commercial process is used for nuts and bolts, springs, window frames, etc. The steel is heated in zinc dust at 340 deg. C. for some hours, producing an excellent coating of zinc alloyed to the steel base.

So much for steel, now a little about non-ferrous metals, brass first :—

Rough Gold: This obliterates fine tool marks, and should not be used where the loss of some metal cannot be accepted. It is suitable for brass "odds and ends." Swab with 50 per cent. nitric acid in water, rinse, dry and lacquer. Do not inhale the brown fumes evolved.

Brown: The same method as for steel.

Silvering: Provided that the work is annealed, and carries very little stress in service, it may be rubbed with a little mercury within a chamois bag. Alternatively:

(1) Dip in 50 per cent. nitric acid for ten seconds.
(2) Wash.
(3) Immerse for a few seconds in:

Mercurous nitrate	.. ..	1 gm.
Distilled water	.. ..	4 oz.

Add 1 per cent. nitric acid immediately before use.

(4) Wipe off excess mercury.

The lustre produced is comparable with chromium plate, but is only suitable for decorative work.

The excellent article on anodising aluminium by Mr. L. Camidge, which appeared in the June 16th issue of THE MODEL ENGINEER, pages 748-749, covers the ground very well, provided, of course, that the work is connected to the positive as pointed out by Mr. Leslie Warburton ("M.E." 25/8/49). How many people know that anodised pure aluminium, unsealed, may be used to hone razor blades, I wonder? Has anyone tried anodised cylinder barrels, sealed with say lanoline, and colloidal graphite?

Frosting is a finish which I often use for light alloys. Dip the work in hot 50 per cent. caustic soda for one minute, rinse in cold water, and dip in 50 per cent. cold nitric acid for one minute, rinse and dry. The result is a lovely silvery white matt finish. Use the caustic out of doors, wearing goggles or old spectacles, as the reaction is rather violent.

In conclusion, whilst not a colouring process, the following solution is a great help when marking out on stainless-steel, which does not respond to the copper sulphate method. Swab the work with :—

Ferric chloride	.. ..	120 gm.
Hydrochloric acid	.. ..	100 ml.
Water to	.. .. ..	500 ml.

Then rinse well and dry. This liquid, which is not particularly dangerous, will produce a light etch on any steel, brass or bronze, and blackens bearing metals. It may be stored in a bottle indefinitely.

Temperatures

Mr. D. H. Newell writes :—"In the penultimate paragraph of his letter on 'Feed Pump Design,' in the November 17th issue of THE MODEL ENGINEER, Dr. Fletcher has made a slight error in defining normal temperature and pressure. Normal (or standard) temperature is zero on the Centigrade scale, and not −273 deg. F. Zero on the absolute scale, is of course, −273 deg. *Centigrade*, not Fahrenheit.

I would like to thank Dr. Fletcher for a letter which will help to eliminate the 'trial and error' method of design."

PRACTICAL LETTERS

International Racing

DEAR SIR,—Referring to Mr. Mitchell's letter in THE MODEL ENGINEER of November 10th, while not intending to take up the cudgels on behalf of Mr. Stone (I think he is quite capable of doing this himself), I would like to point out that according to Mr. Stone's report, a high proportion of the boats were also fitted with American engines, which brings me to the main point of my letter, *viz*: the necessity of an additional European class for amateur-built boats, such as instituted by the M.P.B.A. in this country. I think at the moment this need only apply to "C" class and would give the necessary encouragement to model engineers on the Continent. Perhaps M. Suzor could be persuaded to give us his views on the matter.

In conclusion, I should like to endorse the views of Mr. Mitchell *re* straight running events, and as one who participates in both types, recommend Mr. Stone to compete in these, if only to fill up the waiting period between speed events.

I would also like to see some articles and drawings on surface-propeller hydroplanes, preferably for a 30-c.c. four-stroke engine, as, owing to the unfavourable power/weight ratio, one is up against more problems than the two-stroke with glow-plug.

Yours faithfully,

Carshalton. E. A. WALKER.

DEAR SIR,—Your correspondent, Mr. Mitchell, lets himself down badly by his unsporting attack and his lack of appreciation of the successes gained by Mr. George Stone in France and Switzerland.

There seems to be a class of model engineering snobs in the boat and car game to whom the use of a commercial engine is a crime; they attempt to cover their own frustration by decrying the efforts of others. I would point out that a large number of power boat enthusiasts have been using commercial engines for a longer time than Mr. Stone, but the results are not comparable.

The article on the Swiss regatta was very interesting and did not call for Mr. Mitchell's irrelevant comments about club presidents inviting everyone to a party; surely an appreciation of the Swiss hospitality was justified.

The other remarks are not worthy of comment.

I will be pleased if you will give this letter the same publicity in your columns as that given to Mr. Mitchell.

Yours faithfully,

Reading. FRANK C. CANNING.

Real Smoke!

DEAR SIR,—I was interested in the article in a recent issue about the smoke cartridges evolved by Mr. G. H. Davis.

I have often seen a child point excitedly to the exhaust steam issuing from the funnel of my boat, and exclaim: "Ooh, look! There's real smoke coming out of the chimney!" It has called to mind my childhood days and my efforts to fill the tin funnel of a model ship with combustible material that would produce smoke—with disastrous results to the paint on the said funnel! To a small boy, the height of realism is not the ship cleaving the water like "big sister," or the "bone in her teeth," or even her general appearance, but the smoke issuing from her "chimney." That stamps the model as "the real thing!"

Some years ago, I evolved a scheme for making smoke which is so very simple that I have often wondered why I have never seen it fitted to a clockwork or electric model, or seen it described in print.

Briefly, it consists of a small enclosed fan, or blower, driven off the main propulsion motor; its inlet connected by means of a "slip-on" rubber tube to the stem of a discarded tobacco-pipe, suitably modified, and the outlet connected to the base of the funnel. The bowl of the pipe is filled with cigarette ends, or other suitable "smoky" material, the motor started, and a light applied to the pipe. The ensuing clouds of smoke should delight the heart of even "Inspector Meticulous."

The tobacco pipe should be made detachable for ease of filling, and could be held in place by spring clips. The rubber suction tube has to be sufficiently thick to prevent collapsing, of course, but the fan required is a very small one, as quite a gentle draught will produce clouds of smoke. A baffle fitted in the funnel will act as a diffuser and prevent the emission of a thin, unrealistic jet of smoke.

Yours faithfully,

Liverpool. H. WYNN-DAVIES.

A "Bitza" and a Portable

DEAR SIR,—After reading your contributor's article on the subject of Traction Engine "Bitzas," I think a description of a couple of peculiar modifications seen by the writer a short while ago may be of interest.

These concerned a couple of what were originally "Fowler" ploughing engines of the type shown in "Practical Letters" October 20th, and they were owned by a River Clearance firm. The cylinder-block, chimney and motion of the traction engine had been removed, but the original steering-gear was retained.

The motive power was provided by a diesel engine of some 100-120 h.p. mounted low in the bunker to the rear of the hind wheels, in a position formerly occupied by the main tank. The drive to the wheels was through a very short spindle.

I have also recently discovered an ancient portable engine by Robinson and Auder, of Wantage, in a scrap-yard at Wootton-Bassett.

It is approximately in the 7-h.p. class, and it has an exhaust-driven injector on the L.H. side of the boiler.

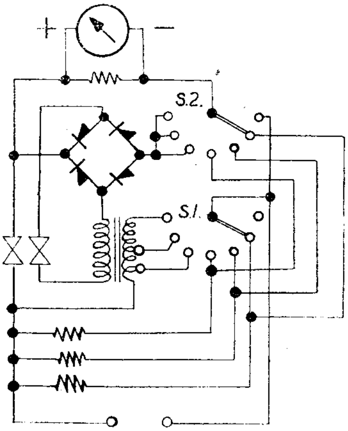
It bears the name of the firm cast-in relief on the valve-chest, and the cylinder-block is surmounted by a Ramsbottom type safety-valve and a chimney crutch.

Yours faithfully,

Malmesbury. H. J. VIZOR.

Voltmeters, Ammeters and Ohmmeters

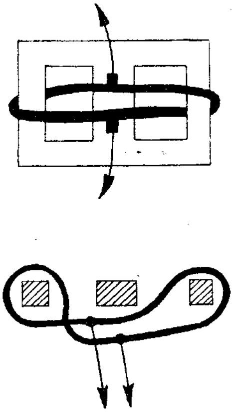
DEAR SIR,—I have read Mr. A. R. Turpin's articles so far with great interest and appreciation. I should like to point out, however, that the circuit of the ammeter can be improved by altering the wiring to the switch slightly, as shown



AMMETER

in the drawing herewith. Any contact resistance in S1 will not then affect the meter reading.

A "half turn" can be wound on the current transformer, giving a 5 A. range in the circuit shown by Mr. Turpin, by winding a heavy wire or piece of copper strip as indicated in the diagram. This type of winding is used in the well-known



"HALF TURN" TRANSFORMER WINDING

Avo multi-range meters. Incidentally, it will be seen that Mr. Turpin and I belong to opposite schools of thought as regards the indication of rectifier polarity, but I don't intend to enter into any discussion as to which is correct.

Yours faithfully,

Topham, Devon. A. M. TUCKER, Grad.I.P.R.E.

Efficiency of Small Locomotives

DEAR SIR,—On page 429 of the issue of THE MODEL ENGINEER, dated September 29th last, is a letter addressed "To Certain Contributors," in which is a paragraph referring to an article written by myself, on efficiency in small locomotives.

In those notes, I gave a suggested method of measuring the work done by an engine, compared to the fuel consumption under certain conditions, which perhaps can be construed as "terms of pounds per B.Th.U. per second," but I freely confess to being quite unable to understand the phrase "putting B.Th.U. in terms of work, reciprocal length per second!" [*sic*].

Perhaps you could prevail upon your correspondent Mr. W. H. Nightingale (Warrington) to give, for the edification of all those interested, his own interpretation of the "meaning of efficiency," and how he himself would set about measuring the efficiency of small locos.

If you could obtain from him a thoroughgoing technical article on the subject, I am sure there would be many grateful readers.

Yours faithfully,

Buenos Aires. C. H. ROBERTS.

Automatic Traversing Gear

DEAR SIR,—In the article by "Duplex" in the issue of THE MODEL ENGINEER (November 3rd), I was rather surprised to see that reference was made, and not, it appeared to me, in a deprecatory way, to the use of the racking gear of the lathe, as a means of machining up to a shoulder. In this connection, may I point out that the rack being of a comparatively coarse pitch, and the control of same, generally being not particularly sensitive or well balanced, the chances are, I have found, that to feed the saddle up to a shoulder, the job stands a very good chance of being ruined by the tool being fed too far into the work, for the seasons just mentioned.

I have, at present, a Myford Drummond lathe, so am free from this particular kind of problem, the knock-out feature being a very efficient one. Before, however, when I had a plain Myford, I used to turn the job, up to near the shoulder, then set the top-slide over to the left, as far as it could go, engage the clasp-nut, and revolve the leadscrew handle, until the tool point was at the position where the shoulder was to be cut. The lathe was then started, and the actual shoulder cut by means of the top-slide, and, of course, fed in to depth by the cross-slide. The saddle being kept locked in position and the clasp-nut disengaged.

I feel that, while a number of readers will doubtless be extremely glad of "Duplex's" article, there are many who would not make the attachment, not caring to spend a lot of time on what they may appear to consider to be only a means to an end; and thought that my method, doubtless well known by turners, may appeal as a quick and simple means of turning up to a shoulder.

Yours faithfully,

Penzance. ARTHUR G. HANN.